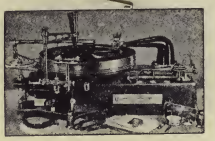
DIRECTORS
JAMES R. FOUCH, PRES.
E. E. GRIFFIN, VICE-PRES.
I. I. SEVEY, SEC-TREAS.



Universal Microphone Co., Ltd.
INGLEWOOD, CALIFORNIA, U.S.A.
EXPORT AGENTS - FRAZAR & CO., 7 FRONT ST. SAN FRANCISCO

ESTABLISHED 1928
MANUFACTURERS OF
Microphones - *Dynamic, Carbon, Crystal, Velocity*
Recording Machines and Equipment
Record Blanks and Accessories
CENTINELA AT WARREN LANE

CABLE ADDRESS U M I C
LOCAL AND LONG DISTANCE
TELEPHONES:
LOS ANGELES THORNWALL 0600
INGLEWOOD 2150

FEBRUARY 10, 1939

TO ALL RECORDISTS AND THOSE INTERESTED
IN QUALITY RECORDINGS

CLEAN CLEAR CRISP RECORDINGS, WIDE RANGE, FULL AND TRUE SINE WAVE BASS, AND PLENTY OF HIGHS -- UP TO 10,000 C.P.S.; NO ABRUPT CUT OFF IN THE HIGHS IS WHAT MAKES QUALITY RECORDING, AND WHAT YOU REALLY WANT AND CAN EASILY HAVE.

IN ORDER TO RECORD QUALITY SUCH AS YOU WANT AND MUST HAVE TO SELL YOUR RECORDS IN TODAYS COMPETITIVE MARKET, WE WILL SEND YOU ONE OF THESE NEW FULL FREQUENCY CUTTING HEADS ON EASY TERMS, LETTING THE HEAD PAY FOR ITSELF. FURTHER, WE WILL TAKE IN YOUR PRESENT CUTTING HEAD REGARDLESS OF MAKE OR AGE AND MAKE YOU A LIBERAL ALLOWANCE.

THIS NEW FULL FREQUENCY CUTTING HEAD WILL SAVE YOU EVERY PENNY IT COSTS IN WASTED BLANKS, IN CUTTING STYLI COSTS, IN TALENT EXPENSE AND IN WASTED TIME, BECAUSE IT GIVES PERFECT RESULTS AND IS STABLE AND UNIFORM, THE SAME DAY IN AND DAY OUT, EVERY DAY.

IT IS ABSOLUTELY AND UNCONDITIONALLY GUARANTEED FOR LIFE.

ONE WILL BE SENT ON TRIAL TO ANY RESPONSIBLE USER ON A TEST AND TRIAL BASIS. IF IT IS NOT BETTER THAN WE SAY IT IS -- IF YOUR RECORDINGS ARE NOT BETTER THAN THEY EVER WERE, AND IF IT DOES NOT PERFORM BETTER THAN YOU EXPECTED IT WOULD, JUST SEND IT BACK.

PLEASE USE YOUR FIRM LETTER HEAD IN WRITING.

YOURS VERY TRULY,

J. R. Fouch

PRESIDENT

JRF:MM

COPY

COPY

DIRECTORS
JAMES R. FOUCH, PRES.
E. E. GRIFFIN, VICE-PRES.
I. I. SEVEY, SEC-TREAS.

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CENTINELA AT WARREN LANE

(AIR MAIL)

March 24, 1939

Mr. Frank E. Schooley
University of Illinois
Urbana, Illinois

Dear Mr. Schooley:

This will acknowledge and thank you for your very kind invitation to submit recording equipment for test as set forth in your letter of March 8th.

Order has been entered and shipment will be made to arrive well before the date of tests, namely April 15th.

There are only two or three angles that should be mentioned. First: we will make shipment direct from here by express and will have no representative in attendance, being entirely willing to rely upon the performance of the machine itself without anyone being present to sponsor it.

We are entirely willing to leave all angles in the hands of your committee.

Included in shipment will be cutting styli and playback needles to be used with the machine being sent.

Also, we will include one of our latest items a constant Frequency pressing that will be, we feel sure of more than passing interest.

The machine being sent, lists at $365.00 as you will receive it and a discount of 40% is allowed to Educational Institutions.

We also build other types of machines: our stationery Professional model with 110 lb. turntable being by far the most popular model we produce, but at this moment we are back ordered on these so cannot ship.

We also have another smaller complete 12" unit in carry-

case which is not as yet in production, but will be able to ship at a later date for test and which should be popular for School use due to two very valuable points. One being use of a 100% synchronous motor, and the other its low list; under $200.00. One can be sent you in the not too far distant future if you desire, for test.

We are at the moment holding shipment because your letter does not indicate current voltage and frequency which we assume is 110V - 60 cycle.

Will you kindly advise by return air mail as to above and shipment will be made promptly.

About the only thing the writer regrets in regard to your tests is the fact that no time or temperature or humidity tests are contemplated as we feel sure a lot of information of practical future use might be gained.

In this connection it might be in order for the writer to recite to you what we have found in our several years of building recorders and shipping to nearly all foreign countries.

A. That temperatures have a very decided effect on frequency response of most cutting heads. We do not consider that a cutting containing any element that is adversely effected by 110 degrees of heat or 95% humidity or both is valuable.

B. Nor do we consider any cutting head that is effected by winter temperatures down to 40 degrees below zero is valuable.

In this connection, some months ago we had a most complete test made of our Aircraft micro hone made by the Department of Air Commerce (Now C.A.A.) and were issued approval numbers for excellence of performance. During tests we put three of our cutting heads through the tests along with the microphones, therefore when we say that our cutting heads will operate in any climate from the Artic to the tropics we know they will do so because we have already tested them under identical conditions.

Our Cutting heads are unconditionally guaranteed for life.

We are enclosing a sheet on our Aircraft microphone tests so as to advise you more in detail to what the actual tests consisted of.

Thanking you for writing us and for the opportunity to submit our product for test, we are

Yours very sincerely,

CC:Ebel
encl.1
JRF:mm

President

DIRECTORS
JAMES R. FOUGH, PRES.
E. E. GRIFFIN, VICE-PRES.
I. I. SEVEY, SEC-TREAS.

Universal Microphone Co., Ltd.
INGLEWOOD, CALIFORNIA, U.S.A.
EXPORT AGENTS - FRAZAR & CO., 7 FRONT ST. SAN FRANCISCO

CABLE ADDRESS U M I C
LOCAL AND LONG DISTANCE
TELEPHONES:
LOS ANGELES THORNWALL 0600
INGLEWOOD 2150

ESTABLISHED 1928
MANUFACTURERS OF
Microphones - *Dynamic, Carbon, Crystal, Velocity*
Recording Machines and Equipment
Record Blanks and Accessories
CENTINELA AT WARREN LANE

April 27, 1939

AIR MAIL

Mr. A. James Ebel
Chief Engineer, WILL
University of Illinois
Urbana, Illinois

Dear Mr. Ebel:

Yours of April 20th received and the writer appreciates your letter very much.

From your letter I have no comment to make as I am a firm believer in average broad results. In average users hands and under all climatic conditions, with special reference to the fact that in the winter months a recorder may be kept in an unheated room and it may not be used for a month or more, or the situation may be reversed and it may be stored in a hot climate where the sun may beat on it; therefore we have seen fit to develope our equipment to perform uniformily under all temperature extremes as well as in dry desert conditions and where humidity is well around the 100 mark.

Your paragraphs covering rotative variation as well as frequency range recorded is naturally very pleasing to us and we trust will be reflected in your final report, which no doubt it will.

We have no comments to make regarding tests made or method of making except to say that they are very much in line with our own ideas and along the lines of our own tests here at the factory.

We are writing Mr. Schooley today to forward the machine to L. G. Cushing of 540 No. Michigan Ave., Chicago.

If you will be attending the Radio Parts Show in Chicago in June the writer will be at the Stevens Hotel, and we will also have an exhibit in space #10, (first on left when entering). I will be glad to have you join me at lunch any day you are at the show where we can sit down and discuss all angles of recording.

Again thanking you for consideration shown our equipment, we are, with kindest regards

Very truly yours,

J. R. Fouch

JRF:mm

President
Dictated By Mr. Fouch
But Signed In His absence

Recording file

FAIRCHILD AERIAL CAMERA CORPORATION

88-06 VAN WYCK BOULEVARD, JAMAICA, N.Y.

7/22/39

CABLE ADDRESS
"FAIRCAM-NEW YORK"

Mr. A. James Ebel,
Cf. Engr. WILL,
Urbana, Ill.

Dear Mr. Ebel:-

As technical supervisor of the tests being conducted for the N E A to furnish information regarding recording machines your task is not an easy one. It seems to me, however, that you have succeeded splendidly in such tests, the Fairchild Recorder among others, in a brief but comprehensive way. I have no complaints, only commendation for the manner in which our recorder was recently tested.

The tests to which you put our recorder parallel those to which our product is put in our development and production departments. I have at present only one suggestion to make and that is to test the matching of frequency oscillator with playback at several diameters instead of only one recording band.

Thank you for the courteous and efficient handling of our tests.

Sincerely
Charles V. Kettering
Sales Representative.

FAIRCHILD AERIAL CAMERA CORPORATION

88-06 VAN WYCK BOULEVARD, JAMAICA, N.Y.

CABLE ADDRESS
"FAIRCAM-NEW YORK"

July 26, 1939

Mr. A. James Ebel, Ch. Eng.
Radio Station WILL
University of Illinois
Urbana, Illinois

Dear Mr. Ebel:-

Thank you for the courtesies extended to our Mr. C.V. Kettering on his recent visit to your University.

He informs us that complete tests were conducted several days ago and we hope you found everything satisfactory. The equipment Mr. Kettering had with him is a demonstrator with our latest improvements incorporated on it. The new production machines which are now in final assembly are considerably better from a mechanical standpoint and we have improved the cutter network. We have succeeded in eliminating the slight peak which was present in the equipment you used for testing. There is no change in the cutterhead itself as this is accomplished entirely by the network which is being incorporated in the production machine. The introduction of this network also enables us to introduce a slight peak at 10,000 cycles. This gives assurance of a gradual rising characteristic on the high end and which we have found to be desirable. The peak at 10,000 cycles is about 3 db above reference at a 1,000 cycles.

In addition to this new model recorder, we are expanding our line of equipment and no doubt Mr. Kettering explained to you the new Unit 227 Transcription Turntable, the 245 Pre-amplifier Equalizer and the Unit 246 Amplifier. In stations where we have installed our transcription turntables, we are receiving most gratifying reports as to the exact turntable performance and constant services these tables are giving. If you have any plans for installing transcription turntables in the near future we wish you would give our Unit 227 every consideration.

Again, we wish to thank you for the courtesies extended to our Mr. Kettering and if at any time we can be of assistance to

Mr. A. James Ebel, Ch. Eng. July 26, 1939

you, please feel free to write to us.

Very truly yours,

FAIRCHILD AERIAL CAMERA CORPORATION

R. H. Lasche

R. H. Lasche - Manager
SOUND EQUIPMENT DIVISION

rhl:fhl

ELECTROSOUND PRODUCTS
INCORPORATED

RADIOTONE RECORDING EQUIPMENT ★ INTEROFFICE COMMUNICATIONS SYSTEMS ★ PUBLIC ADDRESS SYSTEMS

~~520 NORTH MICHIGAN BLVD.~~ CHICAGO ILLINOIS • TELEPHONE SUPERIOR 4475
228 SOUTH WABASH AVE.

July 27, 1939

Mr. A. James Ebel
Radio Station W I L L
University of Illinois
Urbana, Ill.

Dear Mr. Ebel:

Due to circumstances beyond my control it has been impossible for me to contact you in Champaign with our smaller recording machine. With your permission, I would like to postpone this test until such time as either Mr. Peterson or myself can spare the necessary time to make the trip.

Let me take this opportunity of thanking you for courtesies shown in the past and to compliment you on the manner in which the tests for recording machines were carried out. I believe that all tests as outlined in your standard procedure notes were valuable and of distinct interest and under the circumstances were carried out in the best possible manner. Inasmuch as the whole idea of the tests you made had for its purpose a routine check of recording equipment under actual operating conditions and was not designed to be or ever intended to be a laboratory method of procedure.

Beleve me it has been with a great deal of regret that it has been impossible for me to furnish with the smaller equipment the tests that you have outlined to date and I will greatly appreciate any favor you can extend toward extending the time of your closing date.

Kindest personal regards.

Yours very truly,

ELECTROSOUND PRODUCTS, INC.

F. H. Goldsmith

FHG:CD

F. H. Goldsmith

FAIRCHILD AERIAL CAMERA CORPORATION

88-06 VAN WYCK BOULEVARD, JAMAICA, N.Y.

CABLE ADDRESS
"FAIRCAM-NEW YORK"

7/22/39

Bowling Green, Ky.

Dear Mr. Ebel:-

The enclosed just in case Mr. Loache should overlook writing you. He is out of the office a great deal and it is possible he might be delayed past your deadline. If you should use, & find too long, eliminate the 2nd paragraph.

I wonder if I could buy a couple of the photographs when they are ready? So far as I know we have not actually printed photos of frequency runs altho we use the light test exclusively now and it is interesting as well as effective to have in printed or photo form such information. Would also appreciate if you have a minute to describe how you take the photo, if not a trade secret; Enclose for a couple of prints if you can- and send to me, factory address as above.

When will you be apt to reach decision on turn-tables?

Sincerely,
C. V. Kettering

IOWA STATE COLLEGE
OF AGRICULTURE AND MECHANIC ARTS
AMES, IOWA

BROADCASTING STATION WOI

recording

May 27, 1939

Mr. James Ebel
WILL
University of Illinois
Urbana, Illinois

Dear Mr. Ebel,

Thank you very much for the copy of the tests you are giving the recording equipment. I think that we shall give most of these tests to our equipment also just for our own satisfaction.

Our antenna is in operation now. It is a 400' Truscon tower, shunt excited. At present we have a 2000' line from the transmitter to the tower. It is a 1½", buried in fiber conduit and has given us practically no trouble. We had an open circuit at first due to a poor solder job but we lost no time on the air because of it.

The contracts have been ~~filed~~ signed for a new R.C.A. 5D-x Transmitter and for about $3000 worth of audio equipment, also R.C.A. This will go into a building which is under construction now. We hope to be in the new building by about the middle of September. The new location will shorten our transmission line about 800'.

Our first measurements indicated that we did not have as good output from the shunt excited tower as we might expect. We have improved the coupling system since then, but we have not made any measurements on the new arrangements. We do not plan to do much measuring until we get the new equipment installed.

Yours truly,

W. E. Stewart

W. E. Stewart
Chief Engineer - WOI

WES:mo

May 18, 1939

Mr. W. E. Stewart
Chief Engineer
Radio Station WOI
Ames, Iowa

Dear Mr. Stewart:

Enclosed is a mimeographed copy of our standards for recording tests. I might mention that I found it desirable to make two changes: 1. In determining the frequency response pattern I find that it is more accurate to compare the amplitude pattern and the frequency pattern by means of photographs rather than using calipers. 2. An addition to determining turntable stability, count the number of beats between the playback 1000 cycle tone and the oscillator 1000 cycle tone, and that will give you stability in parts per thousand. This presumes of course that the oscillator stability is much greater than that of the turntable.

I haven't heard any news recently concerning the new transmitter and antenna set-up. How about sending along a little?

Best regards.

Very truly yours,

A. James Ebel
Chief Engineer

Chtr

IOWA STATE COLLEGE
OF AGRICULTURE AND MECHANIC ARTS
AMES, IOWA

ENGINEERING EXTENSION SERVICE

May 16, 1939

Mr. James Ebel
Chief Engineer
WILL
Urbana, Illinois

Dear Mr. Ebel,

At the N.A.E.B. meeting at Columbus, Ohio, Carl told about the tests which you are running on recording equipment. We will of course be interested in the results when you have them available.

In the meantime I was wondering if you had available any copies of the tests which you are giving the equipment. We have new Radiotone recording equipment and for my own satisfaction I would like to give it a good test. Carl says that your tests have been carefully worked out and approved by the manufacturers. Hence it would give me a standard by which to make my tests.

I would appreciate any information along this line that you can give me.

Yours very truly,

W. E. Stewart

W. E. Stewart
Chief Engineer - WOI

WES:mo

May 4, 1939

Mr. Paul E. Griffith
Electrical Technician
University of Iowa
Iowa City, Iowa

Dear Mr. Griffith:

I wish to express my appreciation for the suggested modifications you supplied for the NAEB instantaneous recording machine tests. Your suggestions are all well taken and a number of them could have been incorporated in the proposed specifications had they been received earlier. But since the specifications have been sent out to all the manufacturers, there is not a great deal that can be done at this particular time. However, certain of the suggestions will be incorporated if agreeable to the individual manufacturers at the time of the test.

I shouldlike to comment on a few of your suggestions. I think Id is a very good suggestion and could well be incorporated. In IIIc, while the measurement of hill and dale modulation is desirable, I think that it is sufficiently included in the noise level measurement since both recording and playback on that particular measurement are to be made on the same table.

With reference to Item 4, practically all of the comment that I have received on the proposed tests have recommended that this section of the recording tests be omitted, as did you. However, all of these comments have come from engineers. I agree with them that this test is most unscientific, but these machines are going to be used in a number of cases by people who have no conception whatsoever of the scientific side of recording and merely want to know how the recordings will sound. Since all recordings will be played over the same system at the same time some element of comparison should be possible.

Perhaps after conducting this particular section of the test, we shall know better whether or not the result

will correlate with the other measurements made on the machine. Under Item Vb, this suggestion is also a good one and shall be incorporated.

Again I want to express my appreciation for the effort you have put forth in this matter, and should I pass through Iowa City in the near future I'll look you up so that this material might be more fully discussed.

I realize that the tests we are conducting are far from ideal. It is only the first step toward obtaining some sort of standardization in this particular field. I think the experience we will obtain from making these tests will be invaluable in proposing new standards of more complete tests on instantaneous recording equipment.

Yours very truly,

A. James Ebel
Chairman of Recording
Committee

AJE:EH

THE STATE UNIVERSITY OF IOWA
IOWA CITY
DEPARTMENT OF PSYCHOLOGY

April 18, 1939

Mr. A. J. Ebel
Radio Station WILL
Urbana, Illinois

Dear Mr. Ebel:

Carl Menzer has supplied me with acopy of the NAEB "Instantaneous Recording Machine Tests" for my criticism. I am enclosing a list of suggested modifications of the procedure which have evolved from the experiences of Dr. J. M. Cowan, Director of the Romance Languages Recording Laboratory, and myself.

We are compiling a complete bibliography on disc recording which we hope to publish soon in Electronics. Also, Dr. Cowan is translating Buchmann and Meyer:"Eine neue optische Messmethode für Grammophon-platten." This is the article which is of fundamental importance in all recording machine measurements. It will be published shortly, in English.

We are in favor of using the diffraction pattern (light-band width) as a basis for all measurements of frequency characteristics and linearity. The recording levels should also be set from a carefully determined measurement of light-band width and subsequent conversion to stylus velocity in cm/sec.

Recently I spent four days at the RCA Recording Studios in Chicago observing the methods they use in recording all kinds of records. One striking thing presented itself, and that was that they had no standard recording level, but put all the level on the discs that would allow a commercial pickup to play them back without damaging the record. This is a function of the type of program and composition of the sounds entering the system.

Dr. Cowan and I have been working out a set of standards for acetate recording which will enable anyone who knows anything at all about the game to closely approximate the commercial recordings. As soon as we have these completely worked out we will send you a copy.

If there is anything I can do to help in getting this instantaneous disc recording practice stabilized I shall be only too glad to do so.

Very sincerely yours,

Paul E. Griffith

Paul E. Griffith,
Electrical Technician

July 20, 1939

Mr. A. Ginzbourger
Klause Radio and Electric Co.
707 Main Street
Peoria, Illinois

Dear Mr. Ginzbourger:

You will remember that On July 6 we sent you a letter warning of the deadline on our recording machine tests. To date we have not heard from you. Since practically all of the other manufacturers of recording machine equipment have or are going to submit machines for these tests, we are very anxious to have RCA represented.

May We hear from you regarding this matter in the very near future? August 1 is the deadline.

Yours very truly,

A. James Ebel
Chairman
NAEB Recording Committee

AJE:EH

RCA Victor

Klaus Radio & Electric Co.

WHOLESALE DISTRIBUTORS

707 Main Street, Peoria, Illinois

July 21, 1939

Mr. James Eibel
Radio Station WILL
Urbana, Illinois

My dear Jim:

In reference to the recorder, I have turned this information over to RCA of Chicago and they should get in touch with you soon. However, if in the next week you do not hear from them, let us know and we will arrange to bring a portable machine to Urbana for you to run the necessary tests.

Yours very truly,

Al Ginsburger mbg

Sound Engineer.

AG:mbg

July 20, 1939

Mr. Roy W. Beier
Sound Sales Corporation
59 East Van Buren Street
Chicago, Illinois

Dear Mr. Beier:

You will recall that when the tests were made on your recording machines I suggested that you send complete information, including price, on the machines, as well as a statement of yours commenting on the methods used in conducting these tests.

In order that your statement may be included in our report it will be necessary to have it by the first of August. Please make the statement as brief as possible and yet explicit.

Very truly yours,

A. James Ebel
Chairman
NAEB Recording Committee

AJE:EH

July 26, 1939

Mr. Carl Menzer
Radio Station WSUI
Iowa City, Iowa

Dear Carl:

Enclosed is a copy of the tentative report of the NAEB recording committee. This is complete except for a tabulation of the data which is now being collected.

To date we have tested 8 machines submitted by 4 manufacturers, and hope to have tested, before the first of August, 3 more machines submitted by 2 manufacturers. Would you please look this report over and give me your suggestions? I am leaving on my vacation the fifth of August, so I should like to have the report fairly complete by that time.

In all probability I will be wanting to inspect your new studio layout shortly after the fifth.

Yours very truly,

A. James Ebel
Chairman
NAEB Recording Committee

AJE:EH
Enc.

RCA MANUFACTURING COMPANY, INC.
A RADIO CORPORATION OF AMERICA SUBSIDIARY
589 EAST ILLINOIS STREET, CHICAGO, ILLINOIS

July 28, 1939

Millit 6311 Josephson Phone.

Mr. A. James Ebel
Radio Station WILL
University of Illinois
Urbana, Illinois

Dear Jim:

Your letter of July 14th regarding the ultra directional microphone was forwarded to me while I was in Camden and upon inquiring about the status of this new microphone I found that it is still in the development stage and that they are not yet entirely satisfied with the performance they have been able to obtain. Therefore, there is no such unit available for sale and we are not in a position to promise when it will be available.

In reference to the transcription equipment, we announced a new version of our 70-B Turntable at the NAB Convention this month and while we did experience some difficulty due to flutter in acetate recordings we now feel that this has been entirely overcome and for your information, the difficulty was not entirely in the turntable itself. Investigation proved that in most cases the flutter was on the recording due to poorly damped oscillation of the cutting head of the recorder and since the new diamond point lateral pickup of our turntable was more sensitive at the low frequencies than those previously used we immediately thought that the flutter was in the reproducer rather than in the recorder.

To eliminate this, we have added a float stabilizer on our recorders and we have changed the damping and the tonearm suspension of the turntable itself.

The new 70-C Turntable is the same price as the 70-B, namely, $325.00 each with the diamond point lateral pickup and filter. I have no literature at the present time on the new turntables but you will receive a new catalog within the next week or so which will show photographs of the new unit.

$325.00
32.50
291.50

Your letter of July 20 to Mr. Ginzbourger of Klaus Radio and Electric Company, Peoria, regarding tests on recording equipment for the National Association of Educational Broadcasters, has been referred to me and while I am not sure just what you have in mind, I think we can arrange to ship you one of the portable recorders for test. This recorder is

described in the attached leaflet and the portable recorder consists of the turntable mechanism with the lead screw mechanism and reproducing tonearm but no amplifier equipment is included. The price to broadcast stations is approximately $180.00, that is, $120.00 for the turntable plus $60.00 for the recording attachment.

For stations who have either the 70-A, 70-B or 70-C turntables and where it is convenient to make the recordings in the studios, we would recommend the use of our 72-B Recording Attachment which sells for $99.00 and the results obtainable with this attachment are as good or better than the portable recorder shown on the enclosed leaflet.

Please advise if you want me to ship you the portable recorder for test. These units are manufactured in Indianapolis and not much time would be required for shipment.

Best regards.

Very truly yours,

RCA MANUFACTURING COMPANY, INC.

A. R. Hopkins
District Manager
Transmitting Equipment Sales

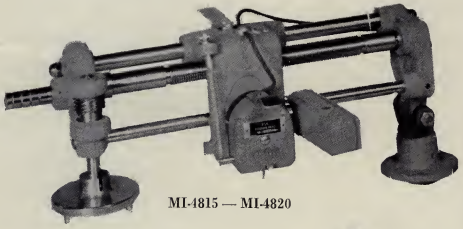
ARH:AK

Encl.

16″ *De Luxe* TURNTABLE FOR RECORDING ATTACHMENT

The RCA two-speed turntable meets a definite need for a high quality portable unit capable of handling 16″ records. The most advanced engineering practice has gone into the design of this unit to assure constant speed. Features include a heavy motor, balanced rim driven turntable, high quality magnetic pickup, two speeds (78 RPM and 33⅓ RPM), master volume and continuously variable tone controls, housed in a neat gray carrying case. Dimensions—Height 14″, width 28½″, depth 23¾″. Net weight, 82 lbs.

MI-4814 Code—SEKVY.....**$236.50**



MI-4815 — MI-4820

MI-4819 — MI-4821

To change recorder attachments from outside-in or inside out cutting, it is only necessary to change the lead screw.

MI-4819—(lead screw inside out).
Code—SELQS **$28.00**

MI-4821—(lead screw outside-in).
Code—SELOQ **$28.00**

MI-4814 Turntable with recording attachment.

With the addition of the RCA Recording attachments MI-4815 (outside-in) or MI-4820 (inside out) the RCA 16″ turntable becomes a high quality portable instantaneous recording unit which can be attached to the RCA De Luxe Master Control or may be used with other RCA high quality Amplifiers.

MI-4815—Recording Attachment (outside-in).
Code—SELGI **$120.00**

MI-4820—Recording Attachment (inside out).
Code—SELMO **$120.00**

Classification:
R. F. SYSTEMS

Bulletin No. SP-1107

RCA DE LUXE RECORDING AND INSTANTANEOUS PLAYBACK EQUIPMENT

MI-12700 and 12700-A

The following parts are standard with both MI-12700 and MI-12700-A:

1 - Console MI-12703	Quantity	1
(a) Pickup Head MI-4864	"	1
(b) Green Shank Needle	"	6
2 - Velocity Microphone MI-4036	"	1
3 - Microphone Stand MI-4068-A	"	1
With MI-12700 only		
1 - Recorder MI-4815 (outside-in)	"	1
(a) Cutting head MI-4896	"	1
(b) Cutting Needle MI-4879	"	6
(c) Feed Screw MI-4821	"	1
With MI-12700-A only		
1 - Recorder MI-4820 (inside-out)	"	1
(a) Cutting Head MI-4896	"	1
(b) Cutting Needle MI-4879	"	6
(c) Feed Screw MI-4819	"	1

Gain Amplifier	105 db.
Frequency Response, Microphone	70-9000
" " Cutter	70-6500
" " Pickup	70-6500
" " Amplifier	50-10,000
with high frequency compensation	
Low Frequency Booster 8 db.	30 cycles
Input Impedances, Cutter	15 ohms
Amplifier	250 & 1200
Loudspeaker	2.2 ohms
Output Impedances, Microphone	250 ohms
Pickup	250 ohms
Amplifier	.53, 2.6, 7.1, 15 and 27 ohms
Voltage required for Cutter Head app.	3.5 volts

Tubes - 2 RCA-6J7 - 1 RCA-6F6
1 RCA-5Y4G
Power required 105/125 60 cycles
Watts 155
Dimensions: 35¼" x 27 x 22
Net Weight: 136 lbs.
Wow Content: 33-1/3 r.p.m. less than .5%
78 r.p.m. less than .5%
Turntable Weight: 23½ lbs.
Turntable Size: 16" Diameter
Synchronous Capacitor Motor 1/75 h.p.
Two Speeds - 78 or 33-1/3 r.p.m.
Recording lines: 112 per inch
Loudspeaker 12¼" Permanent Field
Power Output - 3 watts
Fuse Amplifier 1 ampere

Commercial Sound Section

RCA MANUFACTURING COMPANY · INC

CAMDEN · NEW JERSEY

A Service of Radio Corporation of America

*** Float Stabilizer.
*** Extremely low wow content.
*** Complete with Microphone, cutting unit, amplifier and loudspeaker.
*** Will handle up to 16" records.
*** Can be used for recording or playback.
*** Two recorders available; recording from rim to center or from center to rim.
*** Vertical Pickup MI-4852A can be added.
*** Steel or Sapphire cutting needles can be used.

Playing Time of Records Approx.
112 lines per inch

Record Diameter	78 r.p.m.	33-1/3 r.p.m.
6"	1.4 min.	
8"	2.8 min.	
10"	3.5 min.	5.0 min.
12"	5.0 min.	8.4 min.
16"	7.8 min.	15.1 min.

Starting 1/4" from edge. Minimum diameter 78 r.p.m. $4\frac{1}{2}$", 33-1/3 r.p.m. $6\frac{1}{2}$".

For the best quality recording of 33-1/3 r.p.m. it is recommended that the minimum diameter should not be less than 9".

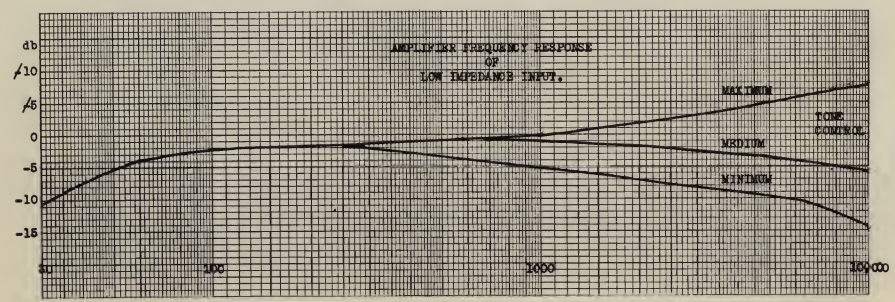
The quality of a line cut at a diameter of $4\frac{1}{2}$" at 78 r.p.m. is the same as a line cut at a diameter of $11\frac{1}{4}$" at 33-1/3 r.p.m.

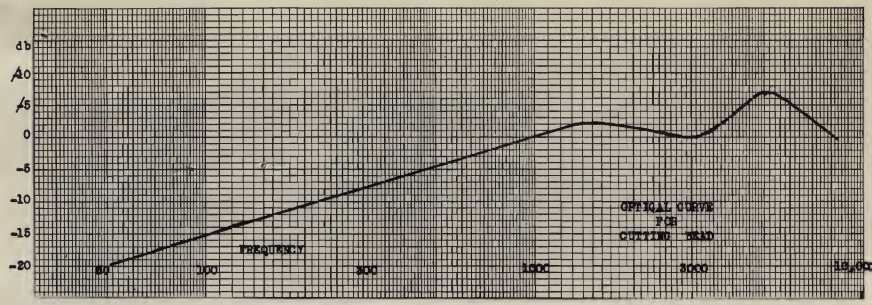
Care must be taken to see that the cutting needle is correctly centered. Cutting needles should be the short type - 9/16" long Approximately.

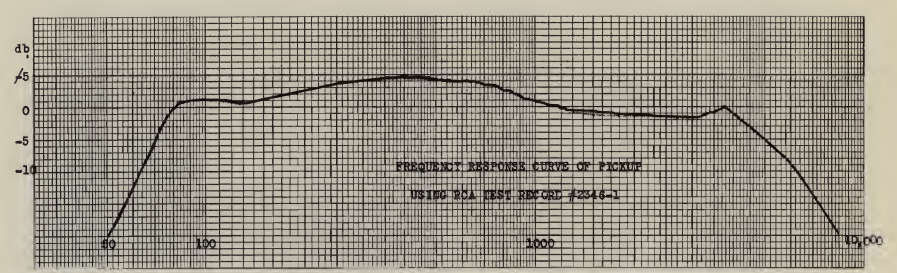
A steel needle should cut for 15 minutes at 78 r.p.m. and for 30 minutes at 33-1/3 r.p.m.

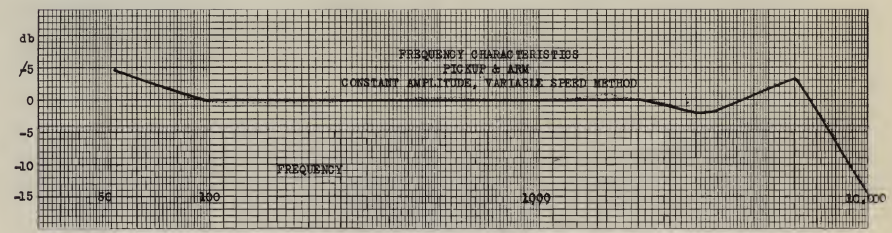
A sapphire should cut for 10 hours at 78 r.p.m. and 20 hours at 33-1/3 r.p.m.

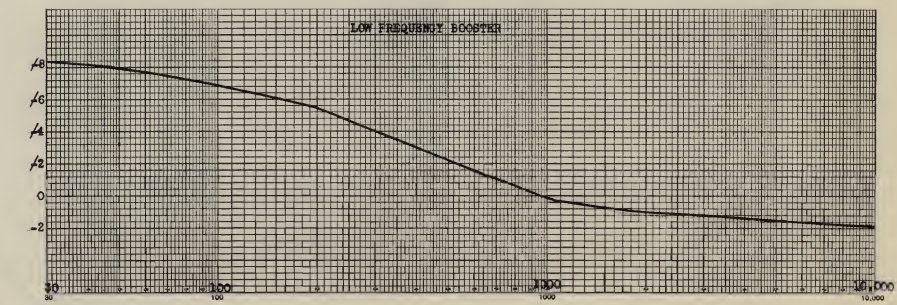
For playback Chromium "Green Shank" needles should be used.

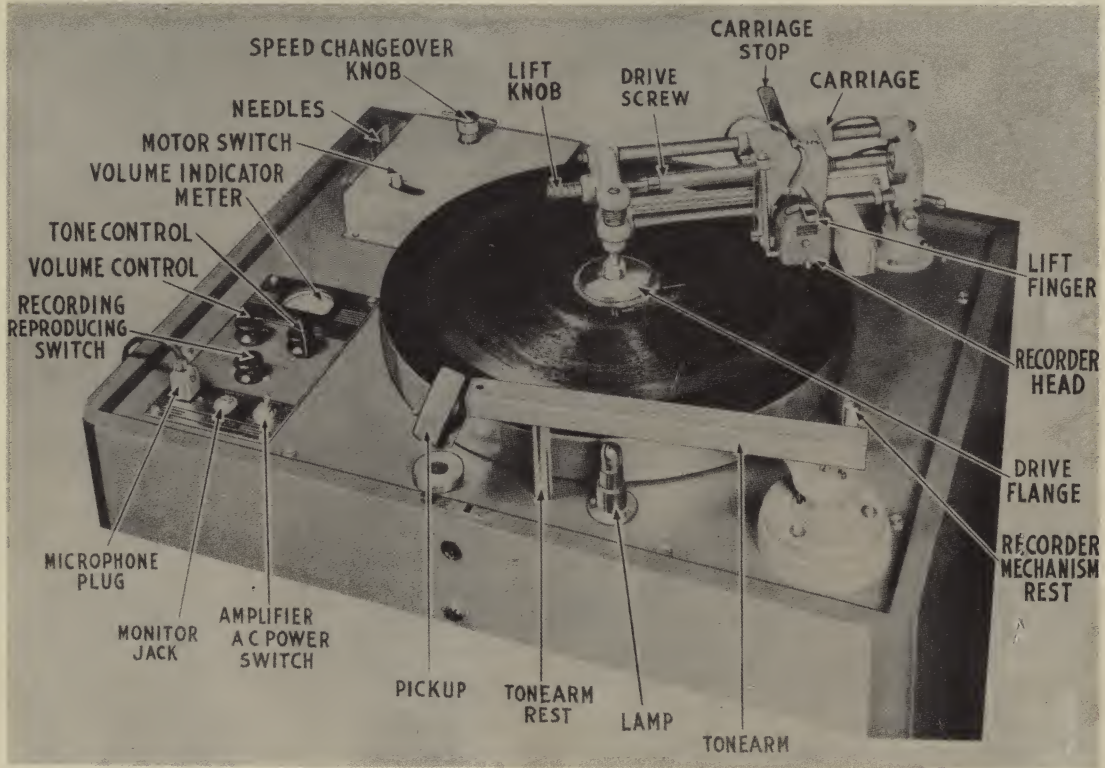



db
+10
+5
0
-5
-10
-15
-20
FREQUENCY
50
100
300
1000
3000
10,000
OPTICAL CURVE
FOR
CUTTING HEAD


db
+5
0
-5
-10
FREQUENCY RESPONSE CURVE OF PICKUP
USING RCA TEST RECORD #2346-1
50
100
1000
10,000


db
+5
0
-5
-10
-15
FREQUENCY CHARACTERISTICS
PICKUP & ARM
CONSTANT AMPLITUDE, VARIABLE SPEED METHOD
FREQUENCY
50
100
1000
10,000


LOW FREQUENCY BOOSTER
+8
+6
+4
+2
0
-2
30
100
1000
10,000


SPEED CHANGEOVER KNOB
LIFT KNOB
DRIVE SCREW
CARRIAGE STOP
CARRIAGE
NEEDLES
MOTOR SWITCH
VOLUME INDICATOR METER
TONE CONTROL
VOLUME CONTROL
RECORDING REPRODUCING SWITCH
LIFT FINGER
RECORDER HEAD
DRIVE FLANGE
RECORDER MECHANISM REST
MICROPHONE PLUG
MONITOR JACK
AMPLIFIER A C POWER SWITCH
PICKUP
TONEARM REST
LAMP
TONEARM

July 28, 1939

Mr. Keith Henney
Editor, ELECTRONICS
330 West 42nd St.
New York, New York

Dear Mr. Henney:

Enclosed is material for an Electronics Reference Sheet. This chart was developed to facilitate measurements on recording machines being made by the recording committee of the National Association of Educational Broadcasters. It has worked very nicely on the fifteen different recording machines which we have had occasion to test.

The curve of Fig. 2 was scaled from the picture, but was reduced to a basis of 1000 cycles equals zero level by dividing the 1000 cycle width into the other band widths.

I sincerely hope you will be able to use this chart. I firmly believe it is a necessity for the recorder.

Yours very truly,

A. James Ebel
Chairman
NAEB Recording Committee

AJE:EE
Enc.

Recording tests

July 29, 1939

Mr. Joseph B. Hersh
David Bogen Co., Inc.
663 Broadway
New York City

Dear Mr. Hersh:

We have just completed tests on the three Bogen recorders which you sent us. While the results have not yet been tabulated, I thought perhaps you might be interested in a general statement concerning performance of the machines in our hands.

The 16 RC model had a very nice frequency characteristic, increasing regularly from 100 to 5000 cycles and then dropping at essentially the same rate from 5000 to 10,000 cycles. The level at 10,000 cycles was essentially the same, or possibly a little higher than the 1000 cycle level. The 5000 cycles was approximately 8 decibels above the 1000 cycle level.

The turntable of this machine was .3 percent. The other two models showed a peak at 2000 cycles and considerably less high frequancy response. The turntable stability for these twowmodels was .7 percent for the 12 RC and a. .5 percent for the 12 RP.

The other data on these madhines has not been collected. You will, of course, receive a complete report on your machine along with a report on the other machines. The tests were conducted as per the specifications except insofar as follows:

Under the Method of Making Tests--

1a. During the tests some machines were encountered which would record only at 78 RPM on a maximum disc size of 12 inches. On these machines cuts were made at a diameter of 8 inches at a speed of 78 RPM.

1b. This section was deleted and standard recording level was taken as that level recommended by the manufacturer. It was pointed out to the committee that the machines in service would in all probability be operated at this level and therefore

ourrnoise level tests would be more valid if made under these conditions. In addition, there is no general agreement as to what should constitute standard recording level.

1e. The frequency patterns were first photographed and the measurements made from the enlargements. We feel that this will increase the accuracy of the measurements many fold. Also the relationship between recorded level and the width of the pattern washchecked using the relations given in Appendix 3.

3b. This out was eliminated and the stability was determined from the noise level out made under 2a which was extended somewhat.

3b. This test was altered as follows: The beats between the recorded note and the standard were counted and the turntable stability was stated in percent age variation. This, of course, alters 3.

These changes were made in the original specifications to increase the accuracy and validity of the tests and I trust that you will approve them.

Before making any tests on any of the machines, two or three records were cut with each machine to familiarize the operator with the operation of the machine and to check it for faulty operation. With the Model 12 RC, we experienced difficulty with the rubber puck creeping up on its shaft when a load was placed on the table. This difficulty was remedied by replacing the puck with one taken from the 12 RP model which didn't exhibit that particular characteristic. As close as we could measure them, the pucks were similar, so I feel that the tests on the 12 RC model are still valid.

Also on the 12 RC model we found the armature to be against one of the pole pieces, naturally giving rise too low level output and high distortion. This was corrected by adjusting one of the set screws on the bottom of the head. We took great pains with this adjustment and as a result got essentially the same characteristics with this head as we did with the head on the 12 RP model, which I believe is similar.

You will note that as part of the specifications for the tests we asked the manufacturer to submit a statement

expressing his opinion on the validity of the tests and making any suggestions for their improvement in the future. I realize that you are at a disadvantage in this respect since you did not have an opportunity to witness the tests personally. However, from the material I have included in this letter, I feel that you can prepare a brief statement. May I have this statement at the very earliest moment since I hope to have the report prepared by the 5th of August.

Your machines will be returned to you freight collect, leaving here July 31. I thank you for your cooperation with our committee.

Yours very truly,

A. James Ebel
Chairman
NAEB Recording Committee

AJE:EH

Cable Address: "BOGENSYSO"

DAVID BOGEN CO., INC.

663 BROADWAY, NEW YORK, N. Y. Telephone GRamercy 7-0500

August 1st, 1939.

recording

Mr. A. James Ebel, Chairman,
NAEB Recording Committee,
University of Illinois,
Urbana, Ill.

Dear Mr. Ebel:-

We thank you for your letter of July 29th, giving us a preliminary result of the performance tests on the three recording machines we sent to you.

Although the results on our machines seem satisfactory, it will be most interesting to compare these with recorders of other manufacture.

We have no comments on the test as outlined in your specifications, as we feel that they are perfectly satisfactory. The only question we have to raise is one concerning which we have had much grief in testing our own recorders. This is the question of blanks. We wonder whether in your tests you have picked blanks which were absolutely flat and true and were absolutely uniform in regard to material. We have experienced considerable variation in our tests, due to variation in recording blanks.

Were these tests conducted with sapphire or steel cutting styli? There will be a difference in results obtained, not only in material of the cutting point but also variation on type of point. We have found that instability or wow may sometimes be traced to faulty blanks or faulty recording styli.

We thank you again for your interest and will look forward to seeing the comparative tabulation on these machines.

Yours very truly,

DAVID BOGEN CO. INC.

JBH/cs
Dictaphone

JOSEPH B. HERSH

MANUFACTURERS

PUBLIC ADDRESS EQUIPMENT — Bogen Sound Systems — CENTRALIZED PROGRAM SYSTEMS

INTERCOMMUNICATION SYSTEMS

August 2, 1939

Mr. J. R. Fouch
Universal Microphone Co.
Centenella on Warren Lane
Inglewood, California

Dear Mr. Fouch:

We have just completed tests on the Unicord recording machine. We had no difficulty whatsoever in operating the machine since there was practically nothing to do but set the head down and let it run. A slight adjustment for the depth of cut was the only adjustment we made.

The frequency response test showed a peak at 200 cycles and another peak at 4000 cycles, and not a great deal of level recorded above 5000 although traces were present up to 10,000 cycles. The other measurements on the machine have not yet been completed but will be submitted to you along with the report on all other machines.

The tests were conducted exactly as were the tests on the other Universal machines which we had. Of course they had to be made at 78 RPM and recording was then Outside-In. Otherwise there were no changes.

We would appreciate a letter from you giving us any additional comments you might have over your previous letter commenting on these tests. We would also appreciate shipping instructions.

Yours very truly,

A. James Ebel
Chairman
NAEB Recording Committee

AJE:EH

August 2, 1939

Mr. A. R. Hopkins
RCA Manufacturing Co.
589 East Illinois St.
Chicago, Illinois

Dear Mr. Hopkins:

We have just completed tests on the RCA recording machine which you sent us. Although complete data has not been tabulated from the measurements, a rough inspection of the light patterns indicates a response up to 10,000 cycles with a slight peak at 5000 cycles. The recording head showed very nice dynamic characteristics also. The noise level was approximately 30 DB below standard recording level.

The tests were conducted as per the specifications except insofar as follows:

Under the Method of Making Tests--

1a. During the tests some machines were encountered which would record only at 78 RPM on a maximum disc size of 12 inches. On these machines cuts were made at a diameter of 8 inches at a speed of 78 RPM.

1b. This section was delted and standard recording level was taken as that level recommended by the manufacturer. It was pointed out to the committee that the machines in service would in all probability be operated at this level and therefore our noise level tests would be more valid if made under these conditions. In addition, there is no general agreement as to what should constitute standard recording level.

1e. The frequency patterns were first photographed and the measurements made from the enlargements. We feel that this will increase the accuracy of the measurements many fold. Also the relationship between recorded level and the width of the pattern was checked using the relations given in Appendix 3.

3b. This cut was eliminated and the stability was determined from the noise level cut made under 2a which was extended somewhat.

3b. This test was altered as follows: The beats between the recorded note and the standard were counted and the turntable stability was stated in percent age variation. This, of course, alters 3.

As stated in the specifications, we should like to have a comment from the manufacturer, giving his opinion regarding the validity of these tests and his suggestions. Since the report is now in the process of preparation, I would appreciate your comments, if any, at the earliest possible moment.

I want to thank you for the efforts you put forth in obtaining the machine for these tests. Please send me shipping instructions.

Yours very truly

A. James Ebel
NAEB Recording Committee
Chairman

AJE:EH

August 4, 1939

Mr. Leroy W. Beier
Sound Sales Corp.
59 East Van Buren St.
Chicago, Illinois

Dear Mr. Beier:

Will you please furnish us with the list prices of the three Presto recording machines that we tested--namely, the 6-B, the 12-Y, and the 10-J? Please send this information at the earliest possible moment.

Yours very truly,

A. James Ebel
Chairman
NAEB Recording Committee

AJE:EH

August 4, 1939

Mr. Joseph B. Hersh
David Bogen Co.
633 Broadway
New York City

Dear Mr. Hersh:

I want to thank you for your prompt reply giving us your reactions to the tests.

In respect to the questions you have raised, I feel too that the problem of blanks to be used in such tests is a knotty one. As will be stated in our report, we used the Presto Q disc for these tests, which does not necessarily mean that we recommend this disc as being the best one. However, I don't believe there is any doubt as to the quality of these discs. The weakness we have found in them is the irregularity of the coating; therefore, the discs to be used for these tests were very carefully selected.

As a matter of fact in the hands of the consumer these recording machines will be operated using various types of recording blanks. So ability of any one machine to adapt itself to a recording blank must be considered as a qualification of that machine.

In all of these tests we used styli recommended or furnished by the manufacturer. In the case of your machine, we used a sapphire cutting stylus. As a matter of fact all machines tested used this type of styli.

Will you please furnish us with list prices of the three machines tested. This information is to be part of the report.

I thank you again for your cooperation with our committee in making these tests.

Yours very truly,

A. James Ebel
Chairman
NAEB Recording Committee

AJE:EH

December 5, 1939

Mr. O. Hugo Schuck
Acoustical Engineer
C. G. Conn Ltd.
Elkhart, Indiana

Dear Mr. Schuck:

I wish to thank you very much for your interesting comments on our report on "Instantaneous Recording Machines". I regret I haven't had an opportunity to answer sooner.

The use of the Chromatic Stroboscope in determining speed variation of recording systems is very interesting and I think very valuable. If it were possible to vary the frequency at which the measurements were made, you could easily calibrate the instrument in percentage variation, however, even with the fixed 440 cycle frequency, you should be able to estimate rather closely the percentage variation. With regard to the measurement of amplitude distortion, I think your comments are very pertinent. The input versus output curves which we used will, of course, only indicate distortion due to asymmetrical wave forms. This will not give any of the odd harmonic components.

The use of a pick up and distortion meter is very satisfactory if the distortion introduced by the pick up is known. This might be obtained by purposely adding known amounts of distortion to a recording. The measure distortion would not only contain the known amount but also the distortion of the pick up devise. Of course several distortion measurements would have to be made because the residual distortion in a recording head can not be eliminated.

With regard to the units used, we measured the pattern widths in millimeters and converted them to decibels, however, since the various recording heads took different power levels to obtain standard recording levels, the units had to be arbitrary showing only the relationship between the input and output of arbitrary units. I think we shoud, however, indicate the standard recording level for each type head, thus standardizing the ordinates of the various curves.

I am very interested in your comments on the dubbing test. Of all the tests we conducted, this was the only one to which objection was voyaged and the objection was almost unanimous.

Everyone felt that this test was most unscientific to which I agree, yet at the same time, I feel that there are certain benefits to be gained from such a test. I should be very glad to have further reports on your work. Some time in the future we may again undertake a program of testing. We learned a great deal making the present tests and I feel that we can do a much better job the next time.

Yours very truly,

A. James Ebel
Chief Engineer

AJE:REP

FYI
Return

Jed

C. G. CONN LTD.

World's Largest Manufacturers of

BAND INSTRUMENTS

ELKHART, INDIANA

November 24, 1939

Mr. A. James Ebel
Station WILL
Urbana, Illinois

Dear Mr. Ebel:

We have received the report on "Instantaneous Recording Machines" which we ordered early this month and would like to congratulate you upon the carefulness and completeness of the tests which you made. Where we could make comparison with tests we had run we found the differences quite small.

One test which we did not run was the curve of optical pattern width against electrical input. The departures from linearity which you showed were quite surprising to us. Incidentally, is the electrical input on your curves plotted in millivolts or decibels, and is the pattern width in millimeters or decibels? It would seem that such a curve would be one way of getting the distortion introduced with increase of amplitude. However, we have found that there can be considerable distortion in the wave form without it showing up very markably in the amplitude response curves. At the present time we are beginning to work with a method involving picking up the wave on the record, examining it with a cathode ray oscilloscope, and measuring the harmonic distortion terms with a General Radio noise analyzer. We are using a Sound Specialties Co. dynamic pick-up. This gives for the second, third and fourth harmonic terms respectively, 3%, 4½% and 1½% of the amplitude of the fundamental at 1000 cycles. On Victor 24522-B. When percentage distortion terms are plotted against electrical input, curves similar to those shown on the enclosed blue print are obtained. I would be glad to have your comments on this method.

You might also be interested in the turntable stability test which we use, even though it is at present qualitative rather than quantitative insofar as rapid fluctuations are concerned. You may be familiar with the Conn Chromatic Stroboscope which we manufacture for sale to schools and for related uses. In case you are not, I am enclosing a sheet describing it. We cut a 440-cycle tone from our temperature controlled secondary standard and play it back, picking up the sound with the microphone of a Chromatic Stroboscope. If the frequency of

playback is not exactly 440 cycles (there is usually a rise due to the frictional slip of the drive mechanism during cutting) it will be necessary to adjust the knob on the fork unit and the pitch rise can be measured directly in hundredths of a semitone or cents. Short period fluctuations can be seen as motion back and forth of the pattern. The extent of this motion can be measured by adjusting the knob on the fork unit to produce motion in only one direction and then in only the other direction. This can be done if the swing is not more than perhaps three a second, but at higher speeds only a qualitative estimate can be secured. This method also demonstrates very definitely the differences in the pitch rise at the inside and at the outside of a record due to the greater torque required when cutting the outer portion. To illustrate I am enclosing curves taken last year on a Presto machine by this method. The pitch rise in cents is plotted against the radius at which the cut was made in inches. We have also found that the resistance of the record material to cutting produces a considerable change in torque as shown by the irregularity of curves taken on points 1/10" apart. A case in point is included. The deviations shown on both of these curves are so great that it is unlikely that the method of counting beats would be feasible. I wonder if you have had much experience with the disadvantages of such a pitch rise of playback and would be interested to have your comments on this line.

The dubbing test seems like a very satisfactory method for making comparisons of recording quality and we would like to do some work along this line. As we understand it, the standard record was picked up with a high quality pickup and its output fed into the input of the recorder being tested. In order that we have available the same record you used we would like to know the maker and the number of the Hungarian Rhapsody No. 2 which you used in making your tests.

I shall look forward to hearing from you.

Very truly yours,

O. Hugo Schuck

O. Hugo Schuck
Acoustical Engineer
C. G. CONN LTD.

OHS:alm
Encl.-

Conn Chromatic Stroboscope

C. G. Conn, Ltd.
Elkhart, Indiana
Feb. 2, 1938

The Chromatic Stroboscope is a device for the precise and rapid measurement of frequencies in the range represented by the piano keyboard. By an entirely visual method, the deviation of a given tone from the equally tempered scale based on the standard A of 440 cycles per second may be read directly. The Chromatic Stroboscope may be used in piano and organ tuning, investigations of pitch, and musical instruction and demonstration.

THE frequency of any tone lying within the range of the piano keyboard may be determined directly with the Chromatic Stroboscope. In the Stroboscope Unit, as seen in Figure 1, there are twelve windows having the relative positions of the white and black keys of the piano keyboard. The twelve notes of the chromatic octave starting with C are thus represented. Sound picked up by a microphone causes these windows to be illuminated.

Suppose, for illustration, that a piano is available tuned exactly to standard equal temperament, with the "A" string executing 440 vibrations per second. Now if this A is sounded, there will appear across the center of the "A" window a characteristic stationary pattern composed of alternate light and dark bars (See Figure 2). Upon sounding the A an octave higher, a similar pattern appears in the same window, except that the number of bars is doubled and the position shifted. Space is provided for seven octaves, so Figure 1). Since there are twelve windows, space is provided for 7 x 12, or 84 notes, essentially covering the range described.

If the piano string which was previously tuned to the standard A is now tightened, making its tone sharp, the characteristic pattern which originally was stationary will move toward the right. Similarly any note which is somewhat flat will cause its pattern to move toward the left. The direction of motion thus serves to indicate whether a given note is sharper or flatter than standard. This test can be applied over the entire range without any adjustment or delay between observations, since all 12 windows are illuminated at the same time.

Under many circumstances it is not sufficient merely to know that a note is sharp, correct, or flat. It is frequently very important to know *how much* a note departs from standard tuning. This information can be obtained by the simple ma-

Fig. 1

that any one of seven A's within the piano range can produce its own appropriate stationary pattern.

Sounding the seven A♯'s will similarly cause patterns to appear in the "A♯" window, located above and to the right of the "A" window (See

nipulation of a single knob.

Take for example the A on a piano which has been tuned flatter than standard, say to 435 cycles per second instead of 440. In the "A" window a pattern will be seen moving toward the left. Now by moving the knob on the Fork Unit

in the same direction, the pattern may be brought to a standstill, or made to "sleep." The pointer will then read "—20" on the graduated scale above the adjusting knob, thus showing directly *how much* the 435 cycle tone is flat compared to the standard A, the reading being expressed in hundredths of a semitone (cents). If the entire piano had been tuned to equal temperament on this lower pitch standard, then all strings would produce stationary patterns with the pointer at "—20."

Obviously any frequency in the range concerned will always be within 50 hundredths of a semitone from some note of the standard scale. To learn *how much* is its deviation, it is only necessary to adjust a knob until the appropriate pattern comes to rest. The only judgment required lies in deciding when the pattern is stationary. No comparison tone is ever sounded, and all counting of beats or estimation of drift speed is eliminated. Furthermore, deviations are read directly from a single scale which serves for all notes. This is a unique

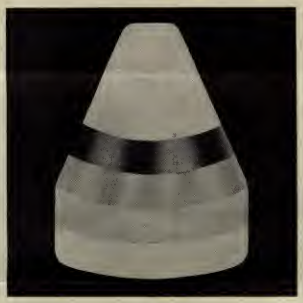


Fig. 2
(Twice Actual Size)

advantage of the Chromatic Stroboscope over other tuning and measuring devices which lack the adjustable feature.

To a certain degree the Chromatic Stroboscope serves to pick out the component frequencies in the sound falling upon the microphone. If, for example, F and A tuning forks be sounded simultaneously, the first correctly tuned and the other sharp, a stationary pattern will appear in the "F" window while another pattern appearing at the same time in the "A" window will move to the right. Measurement of each frequency may thus be carried out independently.

Most musical tones are complex, consisting of a number of component frequencies. Relying upon the selective action just mentioned, one may measure the individual frequencies of these components. Thus, when required, the intervals between them can be found. The same selective action permits measurements to be made in relatively noisy locations without experiencing any interference.

Original Development for Testing Wind Instruments

The Chromatic Stroboscope was developed by C. G. Conn, Ltd., as a means of measuring the intonation of wind instruments. The old method was to count beats between the tone being played by the musician and that of a tuning bar or organ sounded at the same time. Long experience with this method showed that the musician making the test would tend to "lip" the tone so that it would more nearly agree with that of the tuning bar. Often this "favoring" was done unconsciously and even despite the musician's resolve not to do so.

The Chromatic Stroboscope avoids this difficulty by having a standard of frequency which is inaudible. Comparison with the tone of the instrument is made by an independent operator and is entirely visual. In practice, the musician making the test is usually not even allowed to know how the tones he is producing are showing up. The tendency to "lip" into tune is thus eliminated, and the normal intonation of the instrument may be arrived at.

Since the old method of counting beats was very tedious and time-consuming, an aim in the design of the new apparatus was to make it easy to operate and rapid in measurement without making any sacrifice of accuracy. This aim has been realized to such an extent that it is now possible to measure the individual notes in a legato passage. It has been found that in many cases a musician will sound his tuning note unnaturally, the reason probably being psychological. Under such circumstances the error may be minimized by having the musician play a passage in which the note occurs, and making the measurement "on the run."

Has Wide Variety of Uses

While the Chromatic Stroboscope was developed by C. G. Conn, Ltd. primarily as a measuring device for testing the intonation of wind instruments, it has been found adaptable to a wide variety of uses where the accurate measurement of frequency is involved. As various persons in other fields became acquainted with the instrument, they immediately saw how it could be applied to their own problems of sound measurement. For example, piano manufacturers and

tuners saw in it an accurate device for measuring the tuning of the piano. Formerly the only record of *how* a piano was tuned was the memory of the tuner. With the Chromatic Stroboscope an accurate written record may be kept, the deviation of each tone from standard being tabulated. By setting the adjustment knob to these readings, the strings of another piano can readily be brought to have exactly the same tuning. In like manner any arbitrary scale, such as a just scale, may be set up from a calculated table. No adjustment is required for tuning to standard equal temperament. Obviously, the same procedure can be applied in the tuning of any other instrument.

Teaching Ear Training

Teachers of music, bandmasters, and orchestra directors see in this device a means of ear training. Most students now have no other guide in learning correct intonation than by listening to another instrument. If the intonation to which they listen is inaccurate, they will become accustomed to a faulty scale. If all members of a class or ensemble learn to play correct intonation as shown by the Chromatic Stroboscope, they will all learn to play the same correctly tempered scale. Limited experience with the stroboscope in this connection has revealed some remarkable progress by students who formerly played with faulty intonation. To aid those players of instruments which are built in keys other than C, a transposition indicator is provided. For example, if an E♭ instrument is to be used, the pulling of a knob will change the label at the E♭ window to C, this being the written note that must be played in order to produce a stationary pattern at the E♭ window.

Wavering on sustained tones is another fault which can be corrected by using the Chromatic Stroboscope. Such wavering produces oscillation of the pattern. The student can correct this by looking at the pattern and sounding the note in such a manner that the pattern stops oscillating.

Teaching of Harmony and Theory

Harmony and theory teachers see in this instrument a valuable aid in their work. The intervals of the just scale, as determined by the harmonic overtone series, may be demonstrated with the Chromatic Stroboscope. How far these intervals depart from those of the tempered scale may be read directly on the instrument. Notable differences occur in the third, the major third being 14/100 of a semitone flatter (—14 cents) and the minor third, 16/100 of a semitone sharper (+16 cents) in just intonation than in the tempered scale.

The Chromatic Stroboscope thus makes it possible to find out whether just or tempered intonation is preferred in a given chord combination. For example, a certain chord as played by a woodwind quartet was definitely unsatisfactory. By trial the different instruments were tuned until all members agreed that the chord was pleasing. Then the frequency of each note in this pleasing combination was measured and analysis of the results showed that the chord was nearly in just intonation. This indicates that under some conditions intonation other than that provided by strict equal temperament may be desirable. The Chromatic Stroboscope permits the careful study of such effects.

It should be pointed out that, although readings are in terms of the tempered scale, the device does not prescribe that the musician use this scale in his performance. The adjustable feature allows any other possible scale to be investigated.

Use in the Psychology Laboratory

The device is admirably suited to investigating such phenomena as absolute pitch. A subject may be asked to sing, for example, a previously chosen arbitrary series of notes. The frequency of each may be measured, rapidly and accurately, without allowing the subject to hear a reference tone at any time.

Fig. 3

(Actual Size)

The study of subjective pitch has recently become of importance. An observer is asked to adjust the frequency of one tone until it appears to have the same apparent pitch as another, fixed tone of different loudness. The frequency of any variable sound source used in such experiments can readily be found, the reading being in hundredths of a semitone deviation from some note of the standard equally tempered scale.

Use in the Physics Laboratory

The Chromatic Stroboscope is essentially a logarithmic frequency meter, having an accuracy of frequency determination of about 1/20% (0.01 of a semitone) in the continuous range of 32 to 4070 cycles per second. The instrument is direct reading in the logarithmic unit, the semitone, but results may be expressed in cycles per second, when required, by the use of a suitable table. A visual null method is employed, and the frequency measurement is substantially independent of waveform or amplitude.

A particularly interesting application is to the measurement of the inharmonic overtones of struck strings, bars, and bells, advantage being taken of the selective action mentioned before. The convenience of the Chromatic Stroboscope in permitting rapid and accurate frequency measurements should make it a highly useful piece of apparatus in the general physics laboratory as well as in one devoted to sound measurements.

Principle of Operation

The method of measurement employed in the Chromatic Stroboscope is, as its name implies, a stroboscopic one. A familiar example is often noted in motion pictures when a wagon wheel appears to stand still, revolve slowly forward, or revolve slowly backward. Twenty-four frames of the film are projected onto the screen per second. If the spokes of the wheel are revolving at the rate of 24 spokes per second, the wheel appears to stand still. If slightly more than 24 spokes pass a given point in a second there is a gain on the film speed, and the wheel appears to rotate slowly forward. Similarly if there are fewer than 24 spokes passing per second there is a lag on the film speed, and the wheel appears to rotate backward. The spokes appear stationary only when the rate at which the pictures are projected equals the product of the number of spokes by the number of wheel revolutions per second.

In the present case, a gaseous discharge tube is made to flash in accordance with the pulsations of the sound reaching the microphone, and its light illuminates a series of twelve rotating disks which are seen through the twelve windows. Each of these disks is imprinted with the pattern shown in Figure 3, consisting of seven rings of alternate light and dark segments. Each ring, progressing radially, has twice as many segments as the preceding one. When the number of light pulses per second is the same as the number of dark segments passing per second on some ring on one of the disks, that ring will appear to stand still. Since each disk has seven rings of segments, it is suitable for checking the seven octaves above its fundamental speed of rotation. As an example, the 16-segment ring of a disk rotating at 27.5 revolutions per second will appear stationary when illuminated by light flashes occurring at the rate of 440 per second.

The Disk Drive

Since seven octaves are cared for on a single disk it is only necessary to provide 12 disks, one for each chromatic note within the octave. This is the reason for the first part of the name "Chromatic Stroboscope." The speed ratio between adjacent chromatic disks should be that of the equally tempered semitone, that is, the twelfth root of 2. It is, of course, impossible to obtain this irrational ratio by any definite numbers of gear teeth. However, by the successive use of the two gear ratios 89/84 and 107/101 in alternation an exceedingly close approximation to true equal temperament is obtained.

For standard tuning the A disk is driven at 27.5 revolutions per second by a synchronous motor supplied with 55-cycle power by the Fork Unit. Calibrated sliding weights on the tuning fork permit variation of its frequency over a semitone, and since all disks have their speeds changed by the same fractional amount, some combination of disk pattern and speed can always be found which will correspond to any frequency in the range of 32 to 4070 cycles.

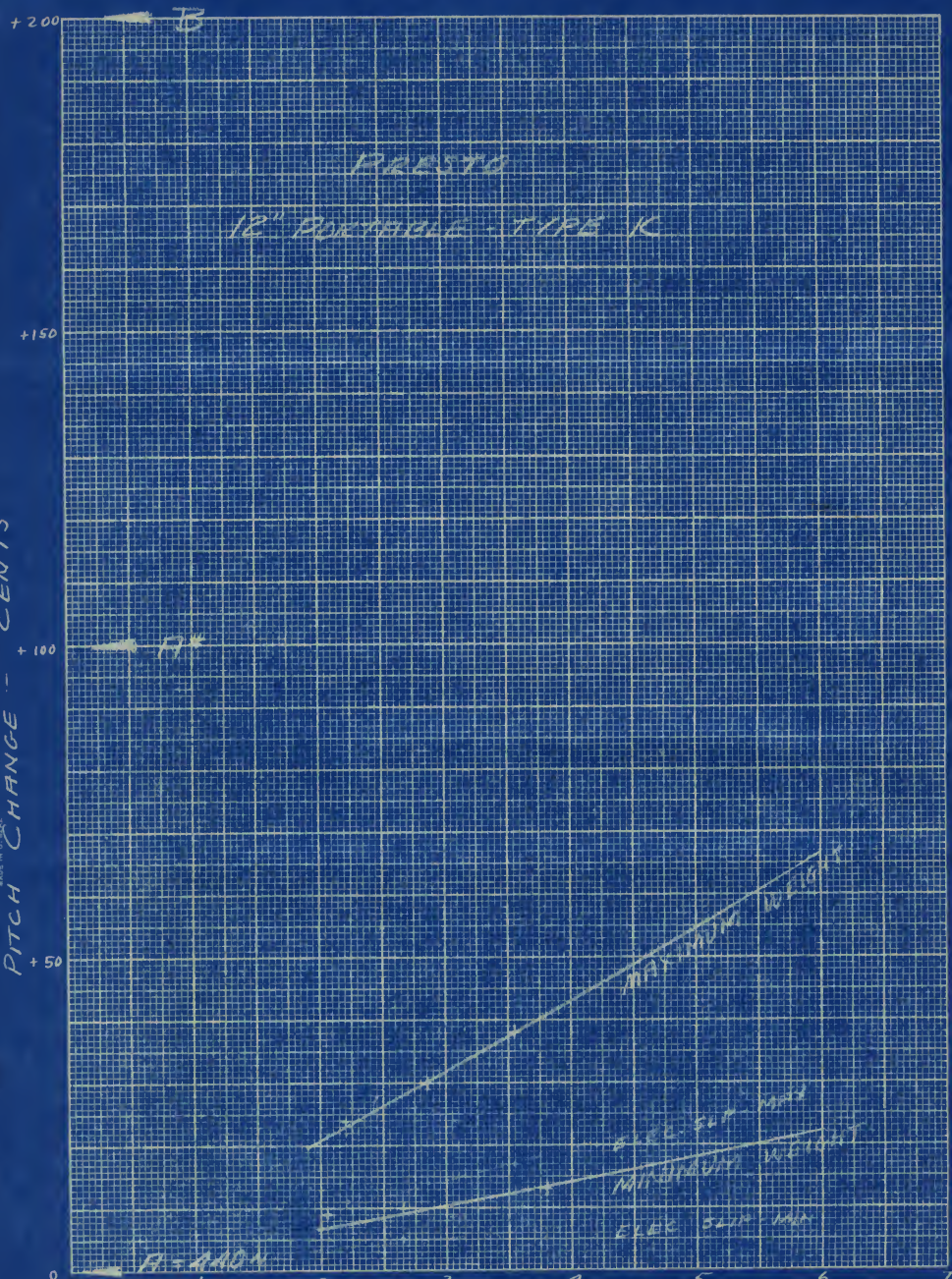
It should be noted that all measurements in this wide range are really made by comparison with a single electrically maintained tuning fork which has been designed to minimize frequency errors resulting from supply voltage and temperature changes. Furthermore, since the disks are interconnected by gears and are not controlled by separate forks, an equal temperament is assured at all times. Thus a single accurately known standard, such as the 440 cycle tone being broadcast regularly by the National Bureau of Standards, suffices to check the calibration.

This arrangement, by which a single, carefully built fork may serve as the standard for all measurements, is the basis for the high order of accuracy and reliability attained in the Chromatic Stroboscope.

Printed in U.S.A.—10-18-38—LG—HWS

RECORDER - PITCH CHANGE vs RADIUS

Whitehurst
11-1-38

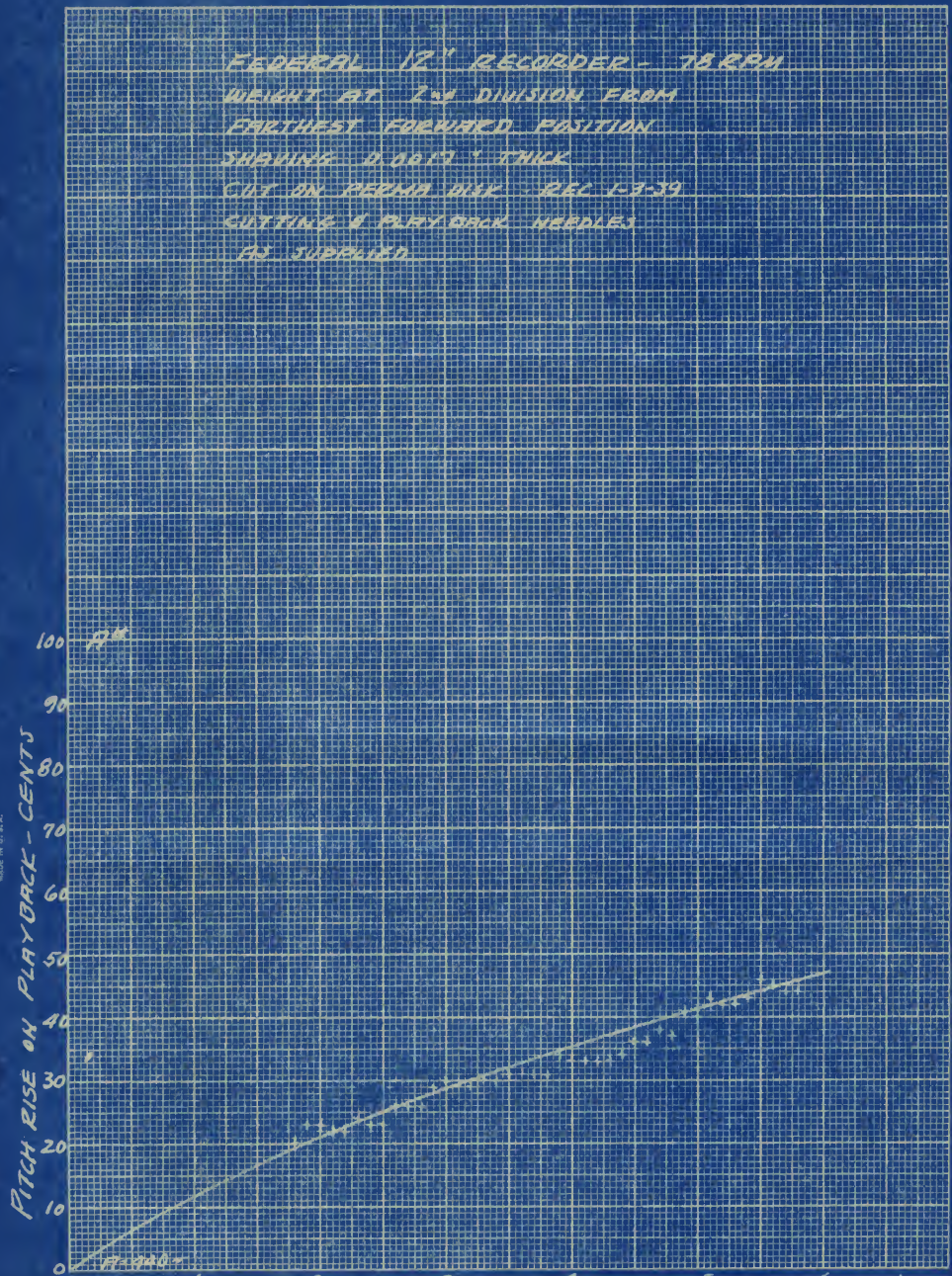


KEUFFEL & ESSER CO., N. Y. NO. 359-11
20 × 20 to the inch, 200 lines each way.
Made in U.S.A.

RECORDER - FEDERAL #829

Ottschuck
1-3-39

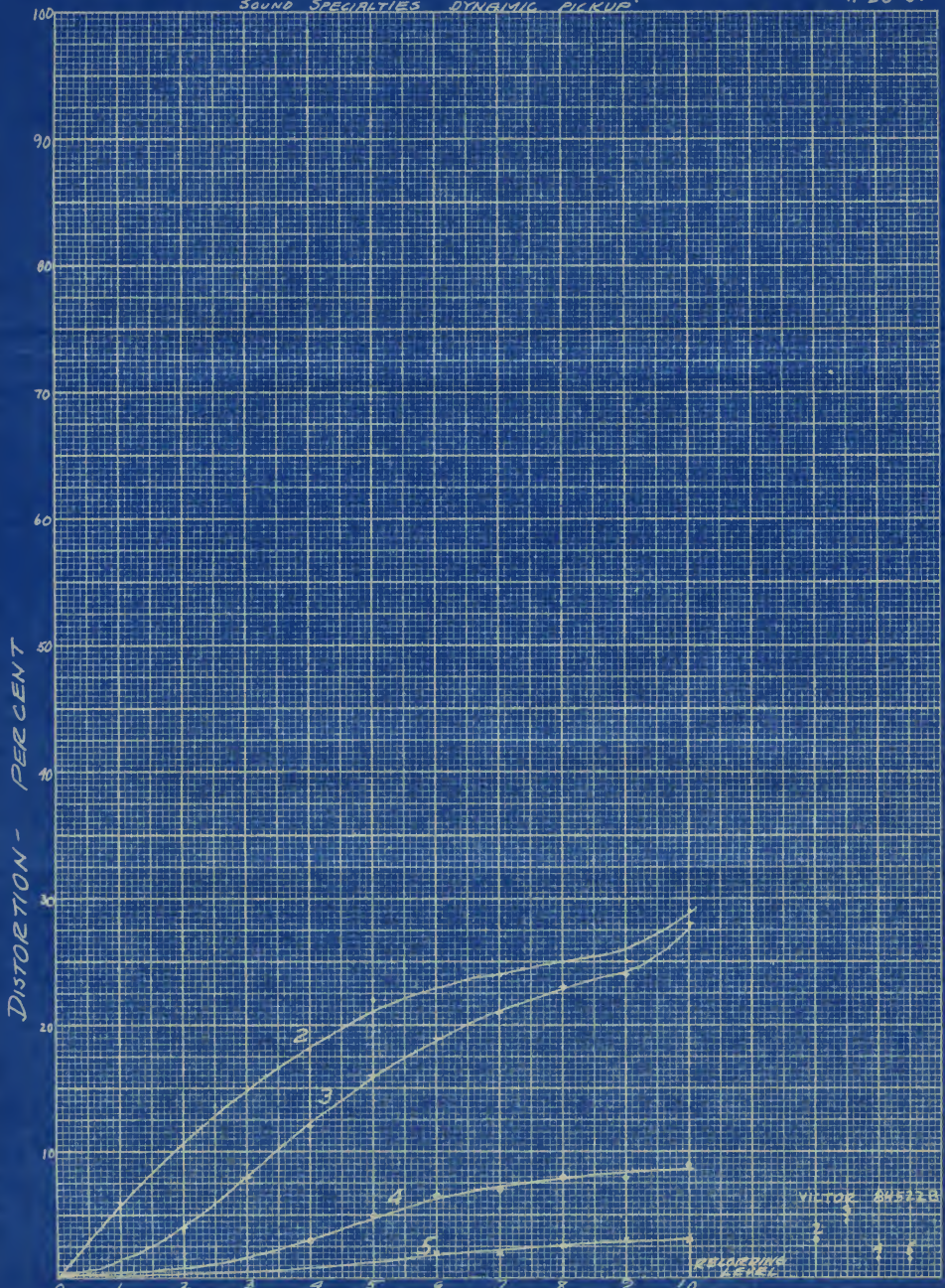
FEDERAL 12" RECORDER - 78 RPM
WEIGHT AT 2¼ DIVISION FROM
FARTHEST FORWARD POSITION
SHOWING LOSS IN TRACK
CUT ON BERRYS DISC REC 1-3-39
CUTTING 4 PLAYBACK NEEDLES
AS SUPPLIED



KEUFFEL & ESSER CO., N.Y. NO. 359-11
20 X 20 to the inch, 10th lines heavy.
MADE IN U.S.A.

RECORDER- CUTTER
DISTORTION OF AUDAK 1F - ACA amplifier
SOUND SPECIALTIES DYNAMIC PICKUP.

Ottschuck
11-20-39



KEUFFEL & ESSER CO., N. Y. NO. 359-11
20 × 20 to the inch, 10th line heavy.
MADE IN U.S.A.

Bogen 212 R-P and 212 R-C

In (D.E.)	Out (D.E.)
+ 4	3.2
7	6
10	7.9
13	10.3
16	12.8
19	16
22	18.7
25	21.4

Bogen 16 R-P

In	Out
4	4.6
7	6.4
10	8.6
13	12
16	13.6
19	16.4
22	20.2
25	22.8

Fairchild

In	Out	
5	0.4	
8	2.3	
11	4	
14	6.2	
17	8	+3
20	10.3	
23	13.2	
26	16.2	

Presto (G-D "Y")

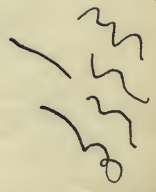
In	Out	
0		
3		
6	4.6	
9	7.6	
12	9.8	+2
15	11.8	
18	12.8	
21	14.2	
24	14.4	

Presto 16-J

In	Out
0	4
3	7
6	8.9
9	10.6
12	12.7
15	15.1
18	18.0
21	21.0

Universal Unicord

In	Out	
0	5.4	
3	6.1	
6	7.6	
9	8.9	
12	10.8	
15	13	
18	15.5	
21	17.5	
24	19.8	
27	21.5	+1



Radiotone "A" & "B"

In	Out
30	
27	22.5
24	19.7
21	16.1

↑ +6

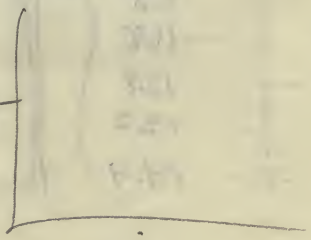
RCA

In	Out
9	8.3
12	11.3
15	14.4
18	16.7
21	20.0

↓ +30

Universal

In	Out
27	21.4
24	19.6
21	15.2
18	13.2
15	12
12	10.3
9	8
6	5.6
3	3.5



Machine	Maximum	Stability	Rubbing test
Rogen 1212 RP	−32 DB	~~35 DB~~ .5	9 fair
Rogen 212 RC	38 DB	.5	8 fair
Unmarked unicord	~~35~~ DB	.2	7 Poor
Presto 10 J	27 DB	.75	11 Poor
Rogen 1C RP	30 DB	.3	1. fair
Unmarked Port	24 DB *	.08	2 good
Presto "Y" 1 head	~~28~~ DB	.25	10 good
Gardhild	33 DB	.15	4 fair
Radiotan	30 DB	.35	5 fair
Presto 6D	20 DB	.2	10 good
RCA	29 DB	.4	6 ~~fair~~ good
Radiotan	29 DB	.35	3 good

WILL DATA SHEET

Equipment tested Universal Unicord Date July 22, 1939

Condition: Tubes _____ Power supply _____

Frequency Response Data:

	Frequency	Output Level
	2000cps	
1	30	0 .006 mw
2	50	+3
3	80	+6
4	100	+9
5	200	+12
6	300	+15
7	400	+18
8	500	+21
9	700	+24
10	1000	+27
11	2000	+30
	3000	+32
	4000	
	5000	
	7000	
	9000	
	10000	
	12000	

Distortion Data at _____ level

Frequency	Distortion
50	.2 % variation in
400	turntable speed
1000	from absolute.
3000	
5000	
7500	

Distortion Data at _____ level

Frequency	
50	
400	
1000	
3000	
5000	
7500	

Noise level _____ below _____

Remarks concerning measurements _____

Engineer making measurements _____

Curve drawn by _____ Checked by _____

WILL DATA SHEET

Equipment tested Bogen 212RD Date July 26, 1939

Condition: Tubes _____ Power supply _____

Frequency Response Data:

	Frequency	Output Level
	2000	
1	30	+4
2	50	+7
3	80	+10
4	100	+13
5	200	+16
6	300	+19
7	400	+22
8	500	+25
9	700	
10	1000	
11	2000	
12	3000	
13	4000	
14	5000	
15	7000	
16	9000	
17	10000	
18	12000	

Distortion Data at _____ level

Frequency	Distortion
50	
400	
1000	
3000	
5000	
7500	

Distortion Data at _____ level

Frequency	Distortion
50	
400	
1000	
3000	
5000	
7500	

Noise level _____ below _____

Remarks concerning measurements _____

Engineer making measurements _____

Curve drawn by _____ Checked by _____

WILL DATA SHEET

Equipment tested Bogan 16 RP Date July 29, 1939

Condition: Tubes _____ Power supply _____

Frequency Response Data:

	Frequency	Output Level
	1000	
1	30	+4
2	50	+7
3	80	+10
4	100	+13
5	200	+16
6	300	+19
7	400	+22
8	500	+25
9	700	+27
10	1000	
	2000	
	3000	
	4000	
	5000	
	7000	
	9000	
	10000	
	12000	

Distortion Data at _____ level

Frequency	Distortion
50	
400	
1000	
3000	
5000	
7500	

Distortion Data at _____ level

Frequency	Distortion
50	
400	
1000	
3000	
5000	
7500	

Noise level _____ below _____

Remarks concerning measurements _____

Engineer making measurements _____

Curve drawn by _____ Checked by _____

WILL DATA SHEET

Equipment tested Bogen 212 RC Date July 28, 1939

Condition: Tubes _____ Power supply _____

Frequency Response Data:

	Frequency	Output Level
	2000	
1	30	+4
2	50	+10
3	80	+13
4	100	+16
5	200	+19
6	300	+22
7	400	+25
8	500	+28
9	700	
10	1000	
	2000	
	3000	
	4000	
	5000	
	7000	
	9000	
	10000	
	12000	

Distortion Data at _____ level

Frequency	Distortion
50	Stability .5%
400	of absolute
1000	
3000	
5000	
7500	

Distortion Data at _____ level

50	
400	
1000	
3000	
5000	
7500	

Noise level _____ below _____

Remarks concerning measurements _____

Engineer making measurements _____

Curve drawn by _____ Checked by _____

Presto Model 10 J 12 inch 1 Speed
and 1 Head.

cut	feed
1	0
2	+ 3
3	+ 6
4	+ 9
5	12
6	15
7	18
8	20
9	
10	

Presto Model Y 16 inch 2 Speed
L-B Head

Mica level and frequency reg.
and turntable mass test only.
use other 1 B head ~~and~~ to amputate curve

WILL DATA SHEET

Equipment tested RCA 9820 Date 8-1-39

Condition: Tubes _____ Power supply _____

Frequency Response Data:

	Frequency	Output Level
1	30	0
2	50	+3
3	80	+6
4	100	+9
5	200	+12
6	300	+15
7	400	+18
8	500	+21
9	700	+24
10	1000	
	2000	
	3000	
	4000	
	5000	
	7000	
	9000	
	10000	
	12000	

78 RPM

Distortion Data at _____ level

Frequency	Distortion
50	
400	
1000	
3000	
5000	
7500	

Distortion Data at _____ level

Frequency	Distortion
50	
400	
1000	
3000	
5000	
7500	

Noise level -28 below Recording Level

Remarks concerning measurements _____

?

Stability — .5%

Engineer making measurements _____

Curve drawn by _____ Checked by _____

Presto Model 6D 16 mm 2 speed

Head – 1-13.

Cut feed 0 = .006 min. 112 lpi.

(a)

Cut	DB
1	0
2	+3
3	+6
4	+9 av
5	+12
6	+15
7	+18
8	+21
9	~~+23~~
10	

(b)

Cut	db
1	0
2	+3
3	+6
4	+9
5	+12
6	+15
7	+18
8	+21
9	+24 (?)

Head #219-4 F 26-199-2 List #4.4 5

WILL DATA SHEET

Equipment tested Fairchild Recorder Date July 21, 39

Condition: Tubes _____ Power supply _____

Frequency Response Data:

	Frequency	Output Level
	30	+20
1	50	
	80	
	100	
	200	
	300	
2	400	
	500	
	700	
3	1000	
4	2000	
5	3000	
6	4000	
7	5000	
8	7000	
9	9000	
10	10000	
	12000	

Distortion Data at _____ level

Frequency	Distortion
50	
400	
1000	
3000	
5000	
7500	

Distortion Data at _____ level

Frequency	Distortion
50	
400	
1000	
3000	
5000	
7500	

Noise level _____ below _____

Remarks concerning measurements _____

Engineer making measurements _____

Curve drawn by _____ Checked by _____

f 1,000 cps Noise level at +20db

1 – +5
2 – +8
3 – +11
4 – +14
5 – +17
6 – +20
7 – +23
8 – +26

Turntable Stability
1.5 cycles per sec

No 42743

UNIVERSAL MICROPHONE CO., LTD.

Packing Slip

CENTINELA AND WARREN LANE -:- INGLEWOOD, CALIFORNIA
TELEPHONES: INGLEWOOD 2150 - THORNWALL 0600

Date of Invoice 3/30/39
Date Shipped 3/30/39
Your Order No. 3/8/39
Shipped Via Express C..
Sales Dept.
Terms Memo

Nat'l. Ass'n. of Educational Br
University of Illinois,
Urbana, Illinois

QUANTITY	DESCRIPTION	UNIT PRICE	PRICE
1	16" Portable Recorder complete 60 cy. #1713		
	with 15 ohm head #868 & Crystal Pickup		385.00
1	Transformer 500 to 15 ohms		5.00
3	"G" Sapphires	7.50	22.50
1	Pkg. Special Acetate Playback Needles		.25
			412.75
	Special Boxing		5.00
			417.75
	Micrometer #118		
	Microscope #3-D		
	Above all sent direct to: Mr. Frank E. Schooley, Sec'y. Radio "WILL" University of Illinois, Urbana, Illinois		
	Backorder: 1 Constant Freq. Test Pressing.		

Merchandise Not Returnable Without Factory Authorization

No. 1 – fair thin. upper Stops.
No. 2 – good – Brass lacks sonority
No. 3 – good+ Brass better than 2
No. 4 – fair – harsh.
No. 5 – Poor – very thin.
No. 6 – fair – not clear.
No. 7 – Poor – harsh + thin.
No. 8. – Fair – balance poor
No. 9. – good first half – change of pitch + poor end.
No. 10. good – after opening bars
No. 11. fair.

1- Fair

2- ~~Good~~ (brilliant)

3- Good (woman)

4- Fair.

5- Fair.

6- Fair +

7- Poor.

8- Fair

9- ~~Good~~ (first half)

10- Fair +

11- Fair

Kitchell.

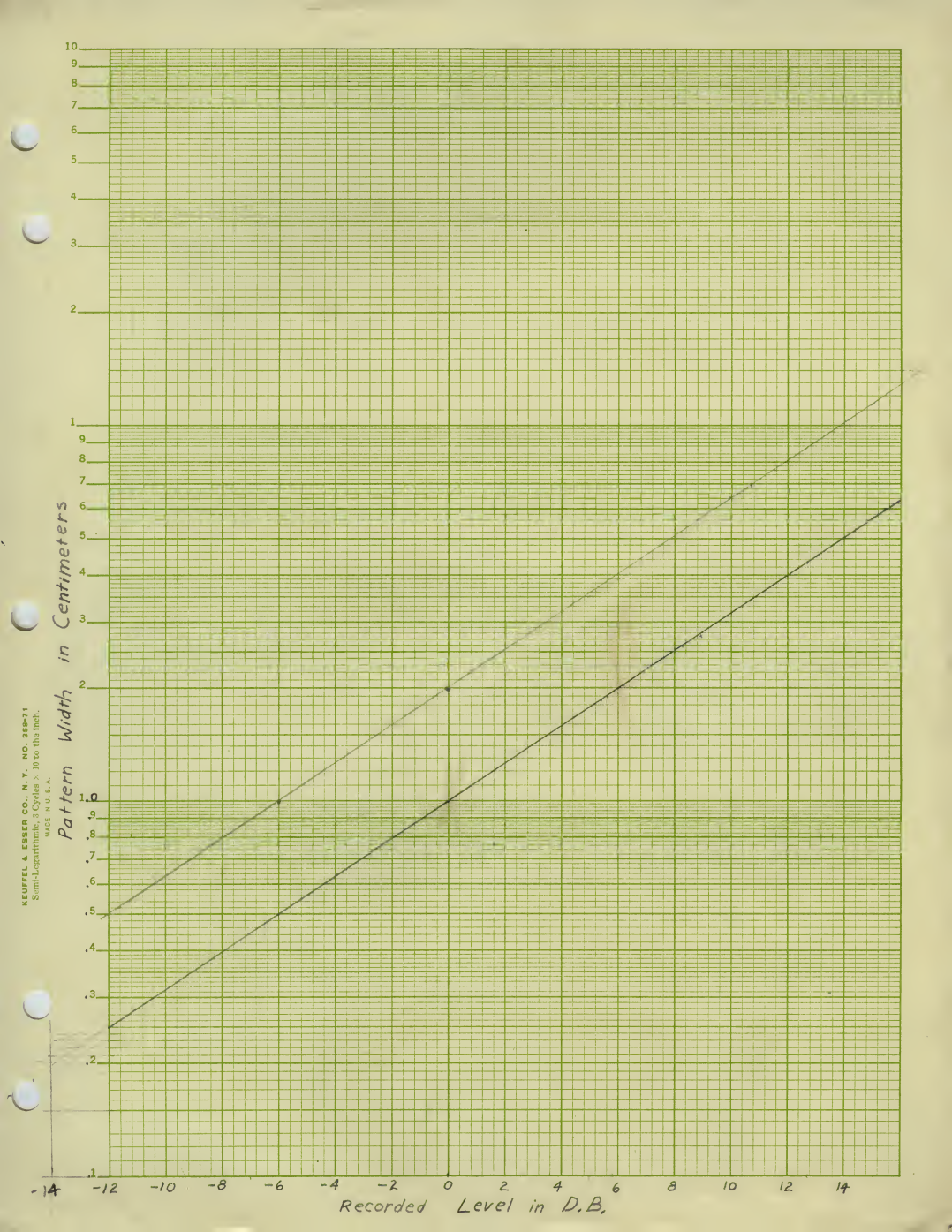
# 1	No good.
2	Universal amp
3	" freq
4	Rogen 212 RC amp
5	Rogen 212RC amp
6	Rogen 212RP amp
7	Rogen " freq
8	Rogen 16RP freq
9	Rogen 16RP amp

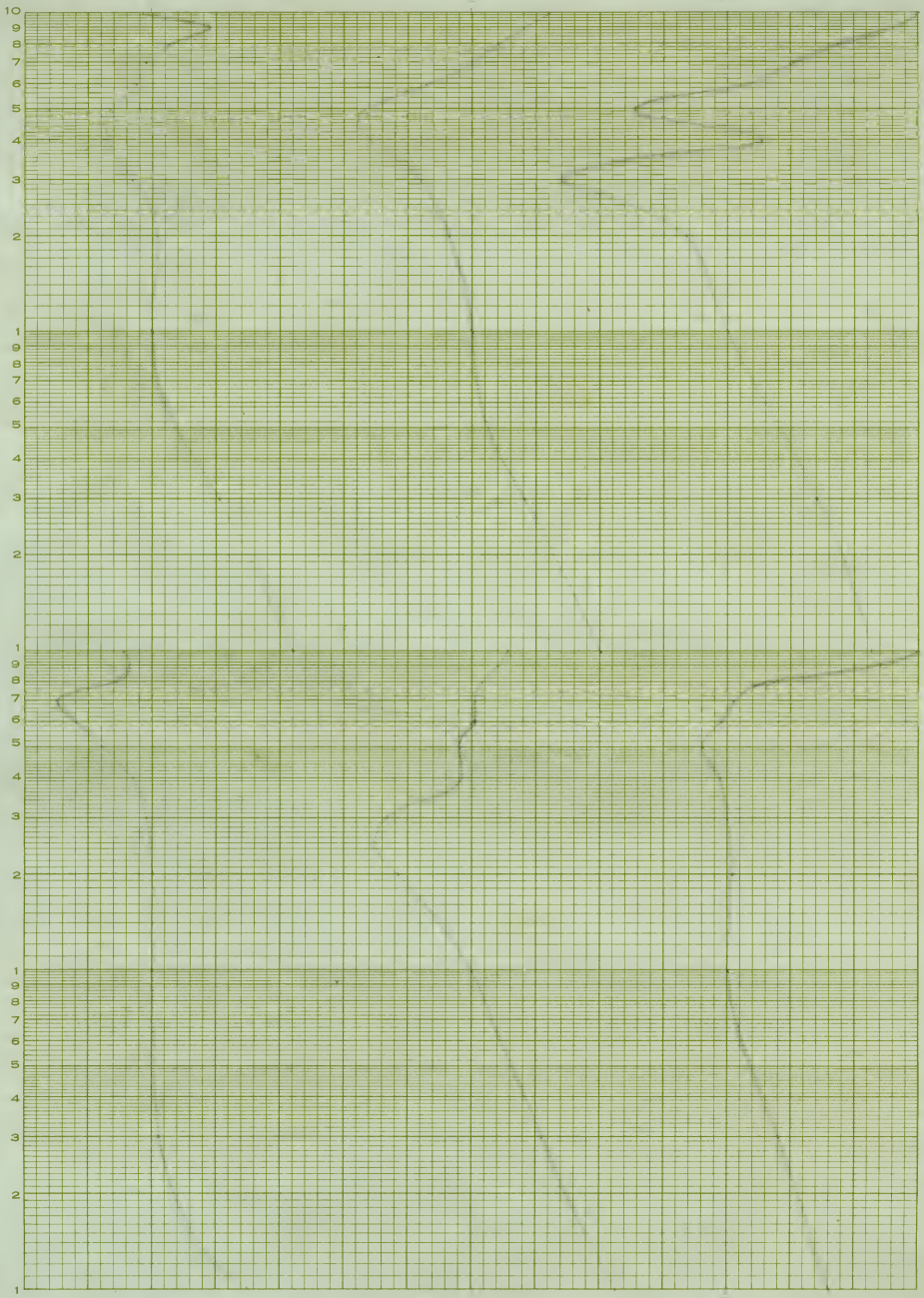
~~Item~~

Crystal Frequency Monitor

equipment Type EX 4180,

thermostat Part # 20

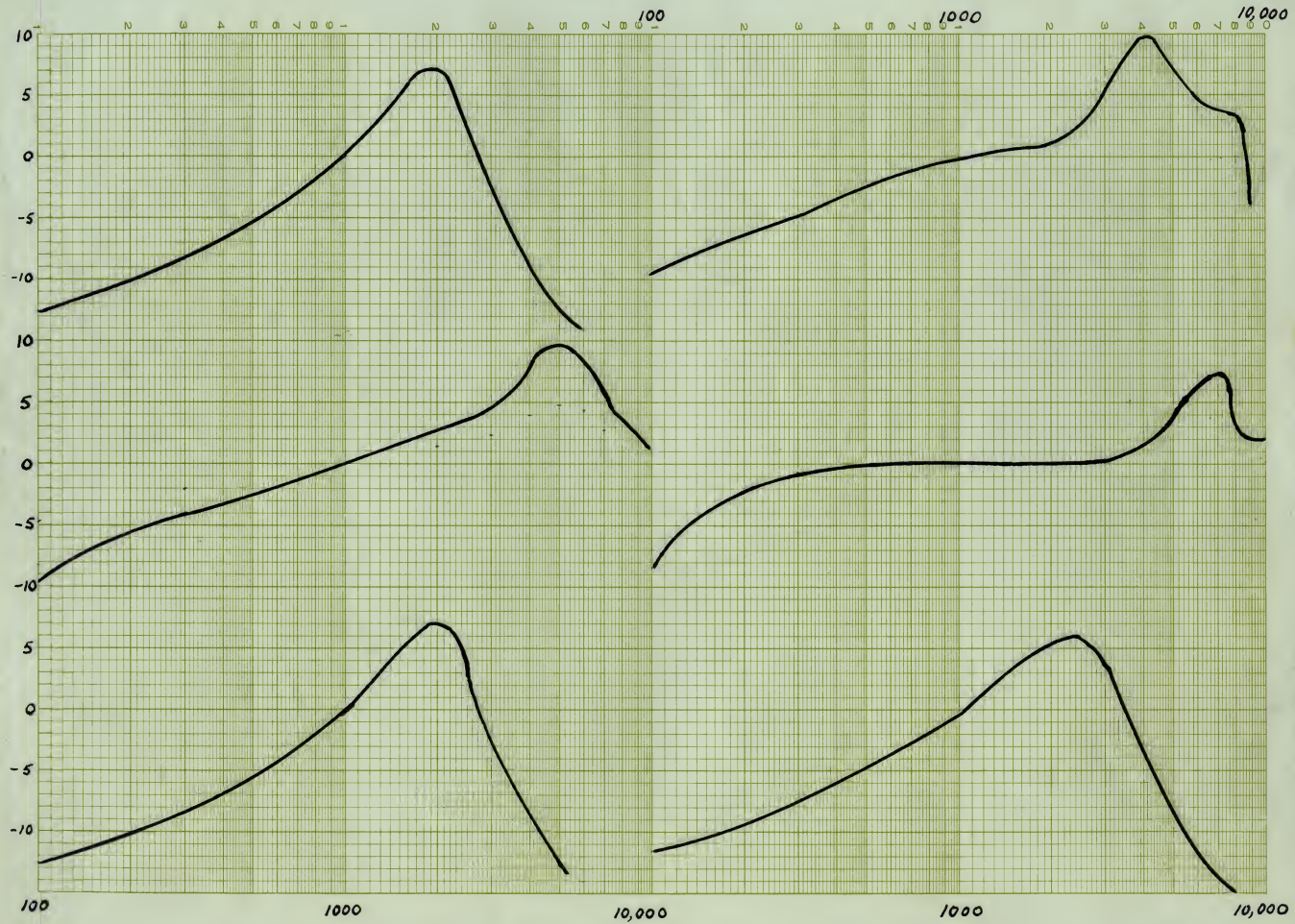

Pattern Width in Centimeters
Recorded Level in D.B.
-14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14
KEUFFEL & ESSER CO., N.Y. NO. 358-71
Semi-Logarithmic, 1 Cycle x 10 to the Inch.
MADE IN U.S.A.



NO. 340-L410 DIETZGEN GRAPH PAPER
FOR SEMI-LOGARITHMIC PLOTTING
4 CYCLES X 10 DIVISIONS PER INCH

EUGENE DIETZGEN CO.
MADE IN U.S.A.

NO. 340-L410 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
4 CYCLES X 10 DIVISIONS PER INCH
EUGENE DIETZGEN CO.
MADE IN U.S.A.



Freq.	D. B.	Presto 10-J
100 ~		
500 ~		
1000 ~		
2000 ~		
3000 ~		
4000 ~		
5000 ~		
6000 ~		
7000 ~		
8000 ~		
9000 ~		
10000 ~		

Fairchild

Freq.	D. B.
100 ~	-9.4
300 ~	-4.9
1000 ~	0
2000 ~	+1.1
3000 ~	+5.1
4000 ~	+9.9
5000 ~	+7.4
6000 ~	+4.8
7000 ~	+3.9
8000 ~	+3.6
9000 ~	-4
10000 ~	-0.8

Presto 6-D
Also Presto "Y"

100 ~	-7.4
300 ~	-0.5
1000 ~	0
2000 ~	0
3000 ~	+0.4
4000 ~	+1.5
5000 ~	+4.0
6000 ~	+6.0
7000 ~	+7.5
8000 ~	+2.9
9000 ~	+1.9
10000 ~	+2.2

(B) Radiotone

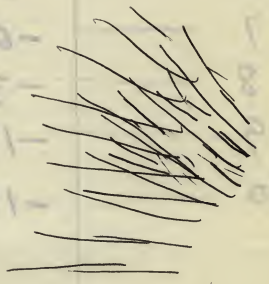
Fr.	D B
100	−8.0
300	−4.0
1000	0
2000	−0.4
3	0
4	0.5
5	2.0
6	0.4
7	−0.4
8	−3.7
9	−12.0
10	−15.0

R.C.A.

100	−11.0
300	−5.2
1000	0
2000	−0.4
3	1.6
4	3.6
5	3.2
6	1.2
7	0.4
8	−1.3
9	−4.5
10	0.8

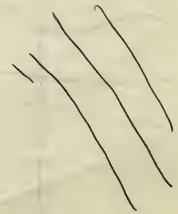
Fr.	DB
100	−11.6
300	−7.6
1000	0
2000	5.4
3	4
4	−2.8
5	−7.6
6	−11.6
7	−13.5
8	−15
9	↓
10	

Preuto 10-J



100	−11.2
300	−5.4
1000	0
2000	5.8
3	6.6
4	0.8
5	1.0
6	−0.2
7	−0.2
8	−0.8
9	−2.0
10	−2.8

(A) Radiotone



F2	DB
100	-10.0
300	-4.0
1000	0
2000	1.8
3	4.0
4	8.0
5	8.4
6	3.6
7	0
8	-2.0
9	-4.0
10	-6.0

Universal

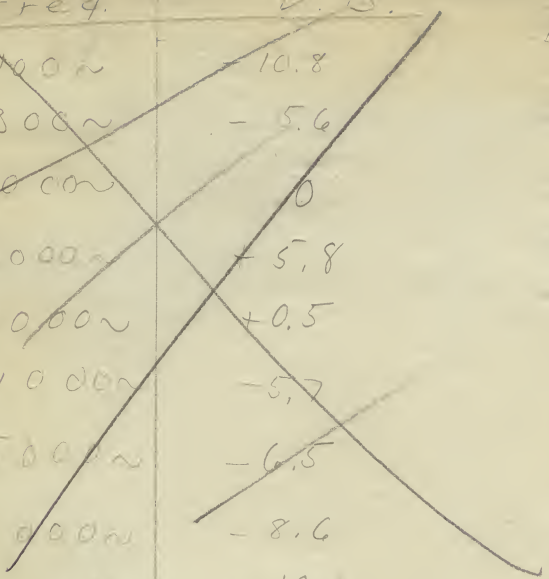
100	-11.2
300	-7.0
1000	0
2000	3.2
3	13.0
4	-2.8
5	7.2
6	-1.8
7	-5.2
8	-8.8
9	-13.0
10	-15.0

Universal

Universal

~~No. 4~~
~~Bogen 212 R-C~~

Freq.	D. B.
100 ~	- 10.8
300 ~	- 5.6
1000 ~	0
2000 ~	+ 5.8
3000 ~	+ 0.5
4000 ~	- 5.7
5000 ~	- 6.5
6000 ~	- 8.6
7000 ~	- 10.0



No. 7
Bogen 212 R-P
+ 212 R-C

100 ~	- 12.6
200 ~	- 8.3
1000 ~	0
2000 ~	+ 7.2
3000 ~	- 2.2
4000 ~	- 8.3
5000 ~	- 12.6
6000 ~	- 14.9
7000 ~	

No. 8
Bogen 16, R-R

Freq.	D. E.
100 ~	-8.2
300 ~	-4.2
1000 ~	0
2000 ~	+2.7
3000 ~	+4.5
4000 ~	+7.1
5000 ~	+9.8
6000 ~	+8.4
7000 ~	+6.0
8000 ~	+3.8
9000 ~	+2.6
10000 ~	+1.1

A Light Pattern Calibration Chart

The art of instantaneous recording has advanced so rapidly in the past few years that today standards for recording equipment are on a level with those of other reproducing equipment. No longer can the recorder employ hit and miss methods in determining the characteristics of his recording equipment. Much has been written in the past in Electronics[1] and other technical publications concerning the light pattern method of determining the frequency response characteristics. Less has been written concerning methods of determining amplitude distortion using the same method. In either case it is necessary to know what power level is represented by the widths of the various bands. Fig 1. is a photograph of the [illegible] of a typical frequency response pattern . While inspection will show that the head records up to 10,000 cycles and has a peak at 5000 cycles, the ammount of equalization necessary can only be determined after evaluating in terms of DB the power levels represented by the band widths.

In 1930 Buchmann and Meyer[2] described a method whereby the recorded velocity can be determined by inspection of the light pattern [illegible] formed when oblique light [illegible] falls on the record. It was shown that

$$V = \frac{WTTN}{60} \qquad (1)$$

where

V = stylus velocity in cm/sec.
W = band width in cm.
N = RPM at which recording was made

a pickup device will, when playing the recording represented by (1) above, generate a voltage which is given by

$$E = \frac{K_p WTTN}{60} \qquad (2)$$

where

E = voltage generated by pickup device
K_p = transformation constant of pickup device

Since N is essentially constant during the recording the constants may be combined and (2) written as

$$E = KW \qquad (3)$$

where K represents the combination of all the constants in (2). If width W_0 gives rise to a voltage E_0 then the constant K may be evaluated as follows

$$K = \frac{E_0}{W_0} \qquad (4)$$

Therefore the voltage generated by any width band may be expressed in terms of E_0 and W_0. If we assume for (assuming width) W_0 zero level output then we can express the output in DB represented by any other (width) band.

$$\text{Recorded level (DB)} \quad 20 \log \frac{W}{W_0} \qquad (5)$$

The accompanying chart shows the plot of this function when zero level equals one centimeter. It might be well to point out (here) that the chart is also valid for zero level equals one inch if the ordinates are taken as inches instead of as centimeters. It is not necessary, of course, that the 1000 cycle value be at zero level since a frequency response curve can be drawn at any level.

The curve in fig 2. was taken from the pattern in fig 1. Since the picture was reduced in printing the levels scaled from the printed as those scaled from the original picture will not be the same/but the frequency response curve will be exactly similar.

In a like manner the amplitude characteristics of a recording head can be obtained. At any given frequency, record a group of bands each band representing a definite increase over the previous band, say in 3 DB steps. Then by plotting the input as abscissas and the outputs, scaled from the light bands on the record, as

ordinates an amplitude response curve can be obtained. Any departure from linearity indicates the presence of amplitude distortion in the recording system.

A LIGHT PATTERN CALIBRATION CHART

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1. March, 1938; McGraw-Hill Publishing Co.
2. E.N.T., 147, 1930

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Recorded level (DB) $20 \log W_o$ (5)

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KNIGHT MODEL 10-R-12 RECORDER - EXCLUSIVE "DUAL ACTION" CONTROL FOR 10" OR 12" RECORDING - EQUIPPED FOR 78 RPM - OPTIONAL CHANGE OVER FOR 33-1/3 RPM - INTERCHANGEABLE DRIVE SCREW FOR IN OR OUT RECORDING SIMPLICITY OF OPERATION ASSURES CONSISTENT RECORDING.

In designing the KNIGHT Model 10-R-12 recorder, the main purpose was to produce a device so simple as to assure good results even when operated by a person of limited experience.

The KNIGHT 10-R-12 recorder differs greatly in many mechanical details from any previous device. It incorporates exclusive design features throughout which render it completely foolproof and simpler in operation than any other recorder on the market. In addition, all adjustments have been either carefully set at the factory or designed so as to make it difficult for meddlers to alter them.

These unusual mechanical features of the KNIGHT 10-R-12 recorder, make it ideal for school and home use assuring consistently uniform and excellent results with a minimum of experience in the art of recording.

The most outstanding feature of this new recorder is the exclusive "Dual Action" control which automatically eliminates record spoilage and needle breakage, for it is impossible to drop the recording head on the record. This control also makes it possible to halt a recording and later continue the recording cut without any gap on the record. The "Dual Action" control eliminates the weight previously required on the record head. It lowers the recording head to the record surface at the same time automatically engaging the recording head with the spiral drive screw, all with the mere twist of the one control knob. All complicated adjustments are done away with by the "Dual Action" control.

The recorder turntable has an internal rim drive powered by a 1/60 h.p., 110 volt, 60 cycle motor. This turntable is dynamically balanced and made of cast aluminum carefully machined and furnished with a rubber record pad. The recorder is adjusted to run at 78 R.P.M. but a drive stud for 33-1/3 R.P.M. is available at a slight additional cost, and the unit can be quickly changed for either speed. The rim drive roller has a friction release of the semi-permanent type but release is not necessary, unless the recorder is to be unused for a period of months.

The KNIGHT recorder features an overhead lead screw drive which is completely enclosed to protect it from dirt or damage. The standard screw provided is for 100 lines per inch, cutting

inside out, but other threads are available at a slight additional cost. All drive screws are machined with the deepest thread available, insuring positive feed and long wear. In addition, the driving nut consists of 5 threads as compared with the usual single thread, thereby minimizing error in the cutting spiral.

The cutting head is of the horizontal magnetic type to reduce the weight of the moveable mass, and is automatically compensated for over-cutting on the low frequencies.

The cutter has a smooth response from 70 to 5000 C.P.S. and is free from objectionable peaks. Cutter impedance is 500 ohms, other impedances are available at a slight additional cost, if specified.

To operate the recorder it is only necessary to turn the "Dual Action" control lever which automatically engages the drive screw while it lowers the cutting head. This unique feature precluded the possibility of damaging the cutting, thereby avoiding waste of needles and records so common in this field.

The recording head carriage automatically stops at the end of the 12" blank record, preventing the jamming of the lead screw and nut and also protecting the needle.

The playback pickup is also a new and recent development, the new Symphonic pickup, utilizing a new inductive dynamic principle. This is a wide range pickup capable of a more linear frequency response than any similar device, assuring unusual fidelity of playback reproduction. Another desirable feature is the extreme lightness at the needle point minimizing needle wear so essential with acetate recording.

The KNIGHT 10-R-12 recorder is housed in a heavily constructed leatherette carrying case for portability and equipped with a removable cover.

E12381 - Price complete as described with carrying case $99.50

ADDITIONAL ACCESSORIES FOR KNIGHT 10-R-12 PORTABLE RECORDER.

R-33	33-1/3 R.P.M. drive shaft pulley for converting 11-R-12 for 33-1/3 R.P.M. recording	$4.34
RWG	Special worm and worm gear for changing 11-R-12 from inside out to outside in recording.	$5.34
RLS	Spiral lead screws and nut for cutting - 90, 100, 120, or 140 lines per inch. Supplied to order only. Specify which type desired when ordering.	$10.00

ACCESSORIES ARE AVAILABLE ONLY ON SPECIAL ORDER AND ARE NOT CARRIED IN STOCK.

Suggested Modifications of the NAEB Instantaneous Recording Machine Tests.

Proposed by

Paul E. Griffith and Dr. J. M. Cowan
University of Iowa

Under

Method of Making Tests.

1. Frequency Response and Distortion Test.
   a. Cuts should be made at a diameter of 12 inches on a 16 inch record at 33.333 rpm at a pitch of 120 lines per inch, and/or 9 inches on a 12 inch disc at 78 rpm. at a pitch of 110-112 lines per inch. The width of the groove in both cases should be 5.5 to 6 mils. With the usual rounded point needle this will give a groove depth of 2.5 mils, which is standard on practically all commercial records.
   b. The normal recording level should be that which which gives a diffraction pattern equal in width to that on the "standard level" record. The test frequency should be 1000 cycles.

   c. The calibrating cut should be 3 db below(b). The frequency run should be made by sweeping the oscillator through the range at a UNIFORM RATE, and marking breaks of sufficient time to give two unmodulated grooves should be made automatically. The input voltage to the recording amplifier should be kept constant. A motor-driven oscillator dial is preferable. The frequency run should start at at 50 cps and contain marking breaks at 100, 300, 500, 800,and 1000 cycles, and every thousand cycles thereafter, until 10,000 cycles is reached.

   d. The cutter-amplifier linearity run should be made at 100 cps, to check for saturation at low frequencies, 1000 cycles, and at the resonant frequency of the head as determined from the frequency run diffraction pattern.

   e. The diffraction pattern should be measured under parallel light rays in order to avoid the correction for recording diameter.

3.c. Unmodulated cuts of at least five lines should be made at the minimum, median, and maximum recording diameters. These cuts should be carefully checked for any variation in width. A calibrated microscope should be used. The frequency-run disc should also be examined for any indication of hill-and-dale modulation. Most recorders have insufficient filtering between the motor and feed mechanism and the resulting spoke pattern on the record is very noticeable.

The spoke pattern is usually at 30 cps, the rotational speed of the synchronous motor used. This test should be made at 78 rpm, as the recording systems are usually most unstable at high speeds.

4. Omit. This test is subject to the influence of too many uncontrollable factors, such as the acoustical characteristics of the room, the playback-system characteristic, and the personal preferences of the judges.

5.b. The record cut in 3 (c) shall be examined for any evidence which may point to uneven feeding of the cutting head across the disc. This fault, of course, severely limits the volume range of the system.

Under "Who Will Make the Tests."

B. Specifications of the discs and cutting needles should be given as completely as possible, since the frequency characteristic of the system can be very greatly altered by these two components.

INSTRUCTIONS and SERVICE DATA

MODEL 212RP PORTABLE RECORDERS

MODEL 212RC RECORDING SYSTEMS

MODEL 16RP PORTABLE RECORDERS

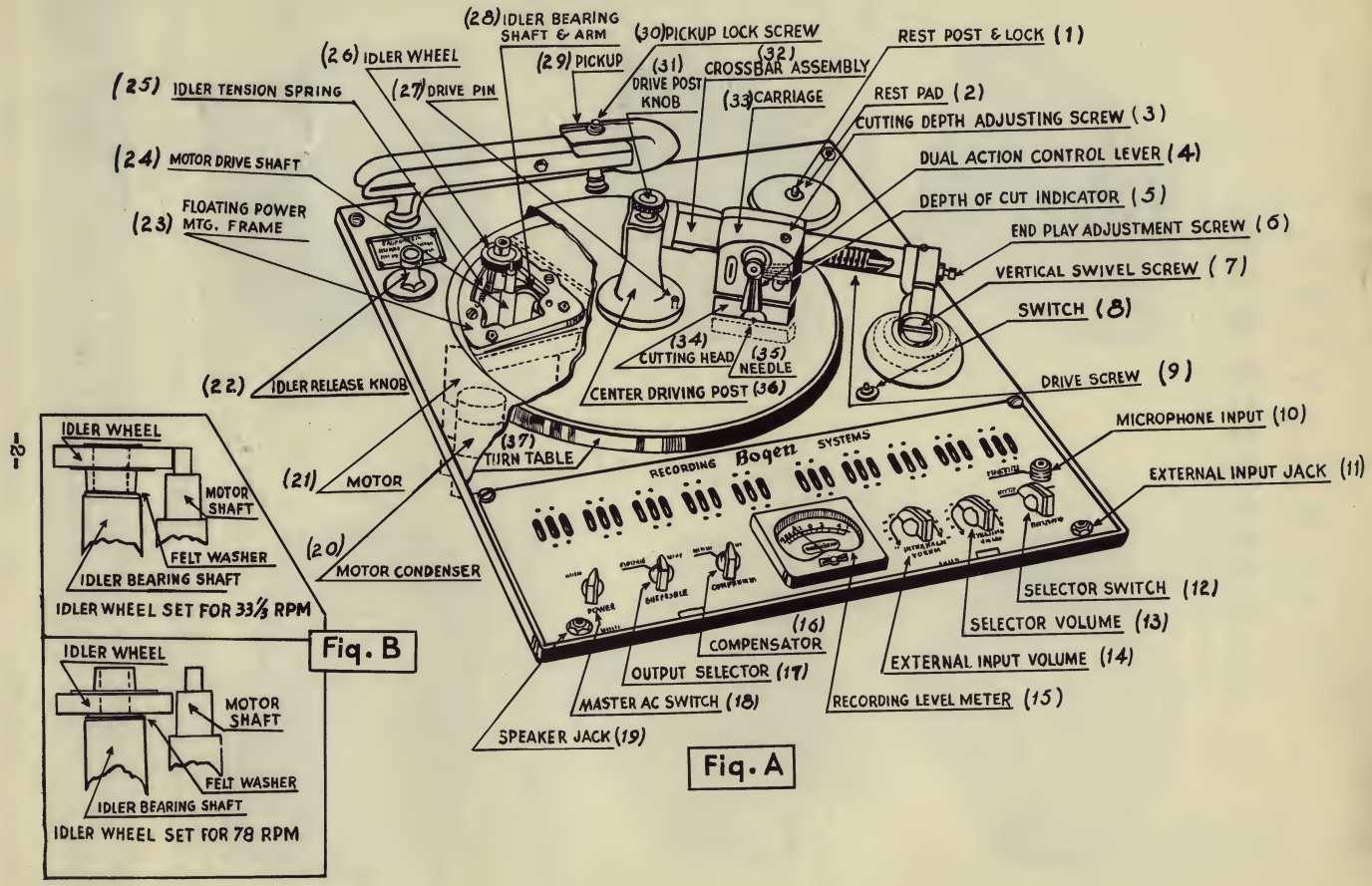
MODEL 16RC RECORDING SYSTEMS

MODEL RA10 RECORDING AMPLIFIER

MODEL RA6 RECORDING AMPLIFIER

— Bogen Sound Systems —

DAVID BOGEN CO., INC., 663 BROADWAY, NEW YORK, N. Y.


(28) IDLER BEARING SHAFT & ARM
(30) PICKUP LOCK SCREW
REST POST & LOCK (1)
(26) IDLER WHEEL
(29) PICKUP
(31) DRIVE POST KNOB
(32) CROSSBAR ASSEMBLY
(25) IDLER TENSION SPRING
(27) DRIVE PIN
(33) CARRIAGE
REST PAD (2)
CUTTING DEPTH ADJUSTING SCREW (3)
(24) MOTOR DRIVE SHAFT
DUAL ACTION CONTROL LEVER (4)
DEPTH OF CUT INDICATOR (5)
(23) FLOATING POWER MTG. FRAME
END PLAY ADJUSTMENT SCREW (6)
VERTICAL SWIVEL SCREW (7)
SWITCH (8)
(34) CUTTING HEAD
(35) NEEDLE
(22) IDLER RELEASE KNOB
CENTER DRIVING POST (36)
DRIVE SCREW (9)
MICROPHONE INPUT (10)
(37) TURN TABLE
(21) MOTOR
EXTERNAL INPUT JACK (11)
(20) MOTOR CONDENSER
SELECTOR SWITCH (12)
SELECTOR VOLUME (13)
(16) COMPENSATOR
EXTERNAL INPUT VOLUME (14)
OUTPUT SELECTOR (17)
RECORDING LEVEL METER (15)
MASTER AC SWITCH (18)
SPEAKER JACK (19)
RECORDING Bogen SYSTEMS
POWER
Fig. A
IDLER WHEEL
MOTOR SHAFT
FELT WASHER
IDLER BEARING SHAFT
IDLER WHEEL SET FOR 33⅓ RPM
Fig. B
IDLER WHEEL
MOTOR SHAFT
FELT WASHER
IDLER BEARING SHAFT
IDLER WHEEL SET FOR 78 RPM

INSTRUCTIONS

Bogen Models 212RC and 16RC Recording Systems
Bogen Models 212RP and 16RP Portable Recorders
Bogen Models RA6 and RA10 Recording Amplifiers

* *

Bogen recording systems are composed of two units - either a 12" or 16" recorder and the Model RA10 recording amplifier, housed in one compact portable carrying case. With the Models 212RP and 16RP an external amplifier is recommended, such as Bogen Models RA10 or RA6.

Power Consumption:-
Model 212RP - 35 Watts
Model 16RP - 117 watts
Model 16RC - 192 watts
Model 212RC - 110 watts
Model RA6 - 70 watts
Model RA10 - 75 watts
For 110 volts AC 60 cycle operation.

An AC cord and plug is provided and connection is made by means of an AC male flush receptacle built in on base plate of 16RC or 212RC recorders. On Models 16RP and 212RP, the AC receptacle is mounted on the side of the case. External connections to amplifiers are described under "Amplifier" heading.

Preparing Recorder for Operation:-
On Models 212RC or 16RC, remove speaker cover from lower section of case by means of slip hinges and set on side. Pickup and crossbar assembly are locked for portability or transportation. Unlock pickup lock screw (30) Fig.A by turning knob to left until pickup can be lifted free. Unlock crossbar assembly (32) Fig.A by turning drive post knob (31) Fig.A until assembly can be lifted free of rest post (1) Fig.A.

Set dual action control lever (4) Fig.A on cuttinghead carriage (33) Fig.A to up or horizontal position. Always keep lever in this position only lowering it to record.

Set recorder for 33-1/3 or 78 RPM, at whichever speed it is desired to record. On the Models 16RC or 16RP speed change is accomplished by rotating speed change control knob, which is located on base plate in lower left hand corner (9) Fig. C. Turn knob pointer to either 33-1/3 or 78 RPM as desired and indicated by engraved plate under knob.

On Models 212RC or 212RP, speed change is effected by reversal of idler drive wheel, located under turntable (26) Fig. A.

Before making speed change on Models 212RC or 212RP, make sure to release the idler wheel from engagement with the motor shaft and turntable rim. This is accomplished by means of the idler release knob, located in the upper left hand corner of the base plate (22) Fig.A. Lift the knob and turn all the way to the left to position marked "OFF" on indicating plate, press knob down before releasing it to make certain that it falls into locking slot provided.

After idler release has been set make speed change on Models 212RC or 212RP as follows:-

Slide cutting head carriage (33) Fig.A all the way over toward center post

(35) Fig.A. then lift and swing the entire crossbar assembly (32) Fig. A. over to the right out of the way so that when the turntable (37) Fig.A. is lifted by inserting two fingers in the holes of the turntable, it is possible to lift the turntable without striking the cutting head carriage. When the turntable is removed, note rubber idler wheel located on the left in back of motor shaft (26) Fig.A. Motor shaft is machined in two steps (24) Fig.A. If idler wheel is set to engage lower step or larger diameter of motor shaft, the recorder is set for 78 RPM (Fig.B.) If 33-1/3 speed is desired, merely lift idler wheel and reverse it, replace on its bearing shaft so that it will engage with upper step or smaller diameter of motor shaft (Fig.B).

CAUTION: - Handle rubber idler wheel gently as the rubber is ground very accurately and it may be deformed by unnecessarily rough handling.

Replace turntable carefully. Turntable shaft will slide freely if inserted properly. Never apply force but rotate gently and lower slowly into place. After replacing turntable turn idler release knob (22) Fig.A. to "on" position, ready for recording.

Setting Cutting Needle:-
To insert cutting needle, (35) Fig.A., slide cutting head carriage all the way back to the point nearest the hinge of the overhead crossbar assembly. (7) Fig.A. Lift the overhead assembly upright all the way over and turn the assembly to a convenient position. In this position the underpart of the cutter (34) Fig.A. is visible and accessible and the needle may be easily fastened into place.

All cutting needles have a flat surface on the upper end of the shank, which fits into the chuck of the cutter. Insert the needle so that this flat side faces toward, and is locked by the needle thumb screw (35) Fig.A. After needle is inserted, lower crossbar assembly over rest post at the right of turntable (1) Fig.A. This is the resting position for assembly when not recording. (Refer to paragraph "Recording Blanks" for further details regarding needle setting for different recording blanks.)

To Record:-
Place a standard Acetate or Phonoflex record blank on the turntable, making sure that the record lies flat. 1/16" thick blanks should be used since the recorder is adjusted at the factory for these blanks. Thicker or thinner blanks are not recommended, but if it is desired, refer to "Raising or Lowering Turntable" under section "Mechanical Data", for necessary adjustments.

Remove crossbar assembly from rest post and swing over to turntable center pin, in position shown in Fig.A. Lower crossbar assembly to fit over center pin and offset drive pin. (2) Fig.A. Turn drive post knob (31) Fig.A. on top of crossbar assembly until it falls into proper engagement with offset drive pin. This will place center post (36) Fig.A. of crossbar assembly flat on the record. Make sure this center post is down perfectly flat against record surface before recording.

If recorder is set for "inside-out" recording, slide cutting head carriage (33) Fig.A. all the way over toward the center of the record. Then slide carriage back to the right just far enough to permit the cutting head to clear the center post base (36) Fig. A when cutting head is lowered. If recorder is set for "outside-in" recording, slide cutting head carriage to a position where cutting needle will be about 1/4" in from edge of recording blank when cutter is lowered for recording. In either case, crossbar assembly and cutting head are now in correct position for recording.

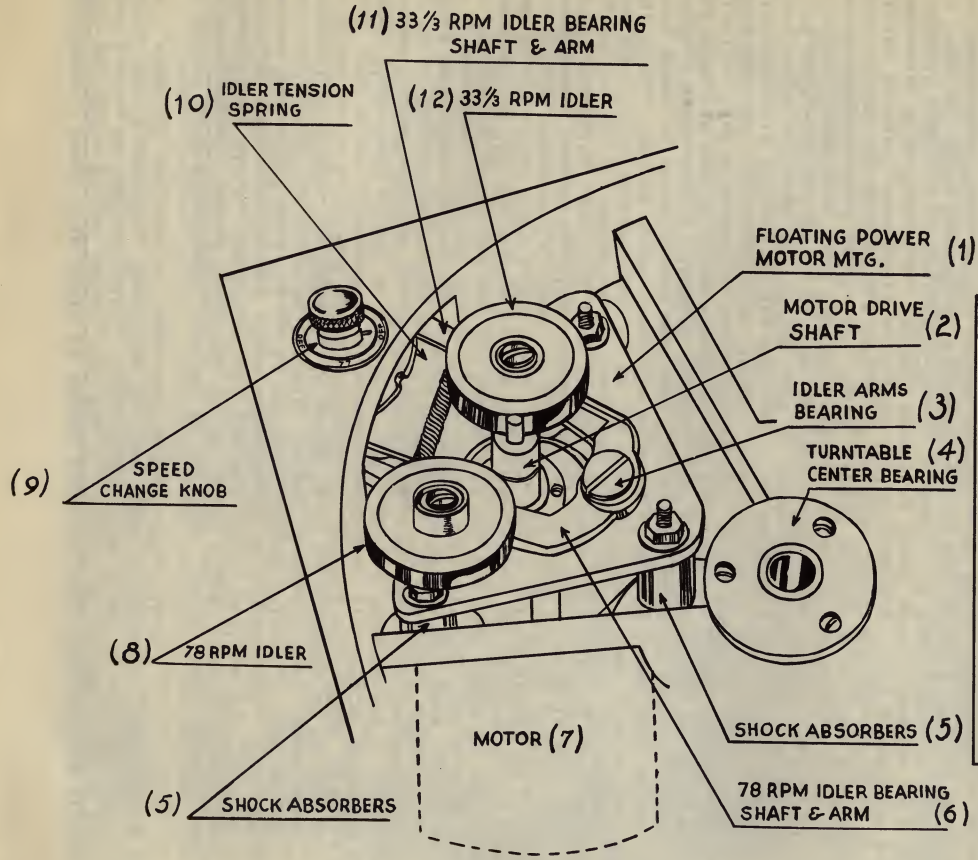

(11) 33⅓ RPM IDLER BEARING SHAFT & ARM
(10) IDLER TENSION SPRING
(12) 33⅓ RPM IDLER
FLOATING POWER MOTOR MTG. (1)
MOTOR DRIVE SHAFT (2)
IDLER ARMS BEARING (3)
TURNTABLE CENTER BEARING (4)
(9) SPEED CHANGE KNOB
(8) 78 RPM IDLER
MOTOR (7)
SHOCK ABSORBERS (5)
(5) SHOCK ABSORBERS
78 RPM IDLER BEARING SHAFT & ARM (6)

Fig. C

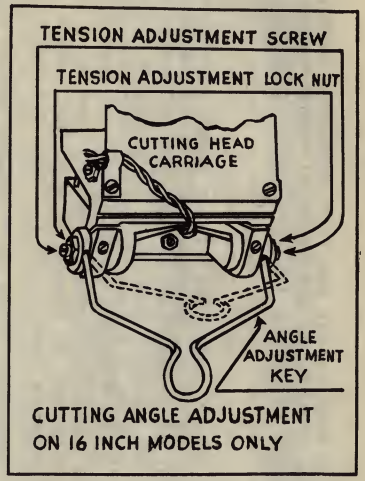

TENSION ADJUSTMENT SCREW
TENSION ADJUSTMENT LOCK NUT
CUTTING HEAD CARRIAGE
ANGLE ADJUSTMENT KEY
CUTTING ANGLE ADJUSTMENT ON 16 INCH MODELS ONLY

Fig. D

Amplifier - Model RA10 built in Models 212RC or 16RC Combinations (Fig.A.) Turn amplifier Master switch (18) Fig.A. located on extreme left of amplifier panel, to "ON" position. Permit amplifier tubes to heat properly for about thirty seconds. Amplifier is then ready to record. Familiarize yourself with all controls on amplifier panel first (Fig.A.)

To record from microphone, proceed as follows: First, make certain that volume controls marked "Selector Volume" (13) Fig.A., and"External Input Volume" (14) Fig.A. are turned all the way to the left to the "OFF" or "0" position before making any other adjustments or connections. Turn switch marked "Selector" (12) Fig.A. to position marked "Micro". Turn switch marked "Output" Selector to position marked "Record. Turn compensator switch (16) Fig.A. to"Speech", if voice is to be recorded or to "Music" if music is to be picked up by microphone. Connect microphone by means of lock type screw connector to microphone connector (10) Fig.A. provided on upper right hand corner of amplifier panel marked "Microphone". Turn "Selector Volume" control to proper recording level which is indicated by the swing of the needle on the meter (15)Fig.A. To determine proper level place microphone before the person making the record and have him speak in a normal tone. Advance the selector volume control until the needle swings to "0" on the scale for maximum peaks. If the average swing of the needle goes beyond "0" the volume is too high, and should be reduced by turning the control down toward the left. If the needle barely swings on the lower end of the meter scale, then the volume is too low and the control should be advanced toward the right until the proper needle swing is attained. After recording level has been determined, make sure cutting head carriage is set ready for recording as described above in paragraph "To Record". See that idler release knob is in the "ON" position, then turn motor switch (8) Fig.A. "ON" to start turntable rotating. Slowly lower dual action control lever on cutting head carriage all the way down to its full stop. If cutting head lever is lowered rapidly, the blank record may be damaged and the carriage may skip one thread of the lead screw. Lower control lever slowly. (For adjustments for depth of cut, etc., refer to "Adjustments"). When through recording, turn control lever upward in a counter clockwise direction all the way to its stop until it assumes a horizontal position. Then slide carriage to extreme left of cross-bar, turn motor switch off, lift cross-bar and swing it over to rest post on the right. Before sliding carriage, make sure that control lever is raised to horizontal position to avoid damaging lead screw. (9) Fig.A. After recording collect cut thread from record and roll into a ball. If acetate blank was cut, dispose of thread in metal container, as thread is inflammable. This precaution is not necessary with Phonoflex. NOTES: Recording level meter operates only in "Record" position of "output Selector Switch". If microphone is used close by recorder while recording, feedback may occur. This is denoted by a squeal or howl. To remedy, merely remove speaker plug while recording.

To Play Back: - On Models 212RC and 16RC, first connect speaker by means of cable and plugs provided, connecting plug to prongs on speaker. Insert male plug in jack on lower left hand corner of amplifier panel marked "Speaker" (19) Fig.A. Turn "Selector" switch to "Playback Pickup", turn "Output Selector" to "Speaker" position. Insert playing needle in"Playback Pickup" (29) Fig.A. and place pickup on record at point where recording was started. (See "Notes") Turn motor switch on and then adjust "Selector Volume" to desired volume level for reproduction. If ordinary commercial records are to be played, remove offset drive screw on the turntable before placing record on table.

Radio Recording or Dubbing:-
To record from radio, an external input jack (11) Fig.A. is provided on lower right hand corner of amplifier panel. Connect two wires from voice coil of radio loud speaker to ordinary telephone plug and insert plug in jack marked

"External Input". Turn selector volume control to "0" position. Turn "External Volume Control" slightly on, then select radio program desired. Proceed as in Paragraph "To Record From Microphone" setting "Compensator" switch to "Music" or "Speech" as desired, and "Output Selector" to "Record" position. Adjust recording level meter for proper volume level as described in paragraph above marked "To Record From Microphone" but use control marked "External Input Volume" to adjust needle swing on meter to proper level. Place crossbar assembly in recording position and record as described previously. To make a recording of a commercial record (dubbing) the procedure is the same as described for radio recording, except that an external phonograph player is used to play the record to be copied or recorded. Connect external phono pickup (high impedance type only) to "External Input" jack by means of an ordinary telephone plug and proceed with all other adjustments as described for radio.

Public Address:-
Turn "Selector" switch to "Micro" position; turn "Output Selector" to "Speaker" position; adjust volume level with "Selector Volume" control and use microphone in usual manner to pick up speech or music whichever is to be reproduced. If microphone is used in same room as loudspeaker, increasing the volume too much will cause what is known as feedback. This is indicated by a "howl" from the loudspeaker and is caused by the fact that the microphone is too close to the loudspeaker. To minimize this "feedback" keep microphone on side and away from loudspeaker as far as possible. To play records for public address use, set recorder amplifier controls to position described under Paragraph "To Playback" and adjust volume to desired level with "Selector Volume" control.

Mixing:-
Mixing or fading of two different signals can be accomplished by means of the two volume controls marked "Selector Volume" and "External Input Volume". To mix when recording with microphone against a musical background, connect microphone in manner described under Paragraph "To Record From Microphone" then connect External Phono Pickup or other source of input signal for musical background to "External Input" jack. Adjust recording level meter for proper swing using both volume controls and proceed with recording in usual manner described above. Mixing can also be accomplished for Public Address use by using the two volume controls on the amplifier panel simultaneously. Any external input device, except microphone, can be connected to "External Input" jack and is controlled by "External Input Volume" control.

Monitor:-
The loudspeaker serves as a monitor when the "Output Selector" switch is in the "Record" position. The signal being recorded is reproduced through the loudspeaker at a reduced volume level. Headphones can be used for monitoring if desired by plugging the headphones into the jack (19) Fig.A. in place of the loudspeaker.

IMPORTANT (Models 212RP and 212RC) Fig.A.
The idler release is provided to eliminate the possibility of flat spots developing on the idler wheel. Always turn the idler release knob to the "On" position when about to record. Make sure, however, that the "On-Off" AC power switch is in the "Off" position. Always use the AC power switch to start and stop the turntable when recording, leaving the idler release in the "On" position. When through recording, release the idler release from engagement with the turntable by lifting idler release knob and turning knob all the way to the left to position on indicator plate marked "Off". Caution:- Do not use the idler release as a start and stop switch when recording. Use it only to engage at the beginning of recording and to disengage when you are through recording.

Recording Blanks:-
When cutting Acetate blanks, the needle should be adjusted to protrude 3/8 of an inch from the cutting head surface. It is recommended that sapphire needles be used for best results on Acetate, although steel needles are satisfactory. When cutting Phonoflex blanks, a short cutting needle should be used and it should be inserted all the way in as far as it will go before locking in position.

When cutting Phonoflex, the needle should protrude as little as possible from the cutting head surface.

It is recommended that steel needles be used for cutting Phonoflex. Steel needles should be changed after cutting the equivalent of three 12" double faced blanks.

ADJUSTMENTS:
To Change Cutting Depth - Insert small screw driver in hole (3) Fig.A. at right of cutting head carriage and turn to right for lighter cut -- to left for deeper cut. A depth of cut indicator (5) Fig.A. serves as a reference point to designate the depth of cut adjustment. The indicator moves up for a lighter cut and down for a deeper cut. Make adjustment on a blank record section as a test, varying the depth of cut until the desired cut is obtained. The cut thread is an indication of proper cut. If thread is dry and brittle the record is too dry and should not be used. Properly cut thread should gleam and should not crumble when handled. Only fresh record blanks should be used.

The cut thread should be about the thickness of a hair and should clear the needle by winding itself around the drive post or at an inch or so from the groove which is being cut. Depth of cut is very important and no amount of printed matter can properly describe it. Experience is the unquestionable teacher. Thickness of thread denotes depth of cut and this varies with weight of cutting head; quality and sharpness of needle; and age and quality of record blank.

The cut thread should not accumulate at the point of the cutting needle -- should be continuously undulated -- almost wavy but not curly nor crinkled. A little patience -- extreme care -- and an intelligent handling of the recorder will give extremely satisfactory results.

To Raise or Lower Turntable:-
Screw and nut under main turntable bearing -- 1/32" per complete turn. If this adjustment is changed, make sure that crossbar is horizontal to record blank within .005". (Refer to "Mechanical Data")

To Take Up Wear on End Play:-
Screw and Nut at right end of square crossbar (6) Fig.A. When a "pattern" or imperfection of cut groove is visible, loosen nut and screw in end play adjusting screw by hand. Make adjustment carefully. Too tight an adjustment will cause the motor to slow down and produce "wows". Too loose will cause an uneven groove cut.

To Change from 78 to 33-1/3 RPM:- Reverse idler drive wheel on 212RC and 212RP.
To Change from 100 lines per inch to others:- Standard recorders are supplied with lead screws for 100 lines per inch. Other screws available: -- 90, 110, 120, 130, 140 lines per inch. Full instructions supplied with lead screw.

To Change for Inside-Out Cutting:-
Standard 16" machines are supplied to cut inside-out. 12" Models are supplied to cut outside-in. TO change either type machine for outside-in or

inside-out, a set of special gears is available to order. Full instructions are supplied with gears.

To Change Cutting Angle:-
On Models 212RP and 212RC cutting angle can be changed by inserting needle further into chuck or bringing needle out further before locking in chuck. On Models 16RP and 16RC angle of needle can be changed by adjustment collars at the rear hinge of the cutting head. Fig.D. A wire cutting angle adjustment key is furnished with these models and should be inserted as shown in diagram Fig.D. into two holes provided on hinge collars. By moving these collars up or down, angle of cut can be changed.

NOTES: - Due to a new design principle of the pickup, in which the needle is the armature, needles of .068" must be used. Ten needles are supplied with the recorder.

All rotating parts of the recorder must rotate smoothly without indication of variable friction. Good oil is essential but must be used sparingly to avoid sticking. Too much oil is just as bad as too little.

Check turntable speed with stroboscope disc. If black lines appear to move in the direction of motion of turntable, speed is faster than 78 RPM. If lines appear to move counter clockwise, speed is slower than 78 RPM.

If black lines are easily followed with the eye, the error in speed is not more than 3 RPM. This error is passable.

Speed may be affected by the following:-
(A) Motor trouble or line voltage fluctuations -- voltage changes in excess of 7% should be avoided.
(B) Old or damaged cutting needle -- do not use steel needle for more than three 12" blanks (6 recordings) -- do not use a steel needle if it has cut accidentally into the aluminum.
(C) Dry (old) or inferior blanks.
(D) Too much, or too little, pressure by motor shaft against idler pulley.
(E) Friction caused by lack of oil in any of the movable parts.

When test or short recording is taken in order to save blank's space, it is not necessary to move carriage to its back stop to play back. At end of test recording, raise control lever, move cross bar assembly to rest post position, and play back. At end of play back, if carriage has not been moved, it is possible to continue the cut just where it left off in the previous cut.

The RA10 and RA6 recording amplifiers have been especially designed and built for these recorders and are recommended to assure best results. However, other Bogen amplifiers may be used. The schematic diagram indicates the impedances and connections. Note that the recorder playback pickup works into a microphone circuit.

IMPORTANT:
Always lower dual action control lever slowly.
Take care of Acetate shavings. They are inflammable.
Make sure that control lever is in horizontal position before lowering crossbar assembly over record blank.
When lifting crossbar all the way over to change needle or oil lead screw, make sure that carriage is either locked (lever down) or all the way to the right.

"Wows" or Waver In Recording:-
"Wows" usually are denoted by a wavering reproduction in the recording and are troublesome mostly when making musical recordings. The recordings will have an unsteady sound particularly on sustained musical notes. There are

many causes for "wows", some are mechanical but very often "wows" are created by poor recording blanks, either old or dry or warped.

"Wows" are probably the most misunderstood cause of trouble in the recording field and this is mostly due to a false conception that most "wows" are due to changes in speed of the turntable.

It is a matter of record, however, that many "wows" are caused by varying depth of cut which causes a varying intensity in volume level.

In order to ascertain if "wow" is due to variation in speed, or to variation in output level, it is only necessary to feed a steady note into the recorder, watching closely the physical rise and fall or motion of the cutting head on the record as the turntable revolves. When this test cut is played back and the playback pickup moves up and down in unison with the "wow" it is a definite indication that this defect is caused by an irregular or warped recording blank.

"Wows" are also caused by dehydration variation in some of the inferior records now on the market. This cause may be detected by listening to the cutting needle as a steady note is fed into the cutting head. Whenever the cutting needle passes over a dried portion of the record, the sound emitted by it will decrease and will increase when passing over a softer portion of the record.

If the record blank does not lie flat on the turntable, objectionable "wows" will surely result and any dirt or foreign matter under the record blank or under the rubber covering will tend to emphasize this most objectionable defect.

Bogen recorders compensate automatically for variation of drag and will not cause any "wows" due to change of motor speed unless the turntable has been accidentally bent out of true or if the "floating power" motor mounting has become loose either in shipping or for any other reason.

Other possible causes for "wows" are as follows:-

Record Slipping:-
This may occur if the offset drive pin (27) Fig.A. were removed to play a commercial record and it was attempted to record without replacing it. Always be sure that the drive pin is in place on the turntable before recording.

Overhead Drive Screw Binds (9) Fig.A.
It is possible that the crossbar assembly may be bent or twisted out of alignment thereby causing the drive screw (9) Fig.A. to bind. Adjustment of the drive screw is described under "Crossbar Assembly".

Motor Drive Shaft or Idler Wheel Binds:-
The recessed turntables on Bogen recorders prevent the possibility of record shavings falling underneath the turntable and becoming snarled or enmeshed in the motor drive shaft or idler wheel assembly. Nevertheless it is possible that over a period of time record shavings may work down and eventually become snarled in the motor shaft or idler wheel bearings (#24-26-28) Fig. A. or (2-3-6-8-11-12) Fig. C, causing binding at any one of these points resulting in "wows". If this occurs, carefully clean all shavings or foreign material from these points and make certain that all points are properly lubricated and move freely.

Slippage between Idler Wheel and Turntable on Motor Shaft Drive:-
All recorders are carefully adjusted for proper driving speed, motor torque

and pressure. However, there is a remote possibility that these adjustments might be loosened or jarred out of alignment. Check idler wheels (26) Fig.A for 12" Models or (8-12) Fig. C. for 16" Models, making certain that no oil or grease is on the rubber surfaces of idler wheels which would cause slippage. Also check idler bearing arms (28) Fig.A. on 12" Models or (3-6-11) Fig. C. on 16" models to determine whether all parts move freely and are not binding. Check Idler Tension Springs (25) Fig.A. for 12" Models or (10) Fig.C. for 16" models, to be certain that these springs are maintaining proper tension and have not loosened up or stretched, losing their spring tension, and that springs bring idler wheels into engagement with motor drive shaft and turntable rim when idler release knob on 12" Models is in the "On" position.

"Flutter" or Cutting Head "Wow":-
"Flutter" is evidenced by a ripple or flutter in the reproduction when a record is played back. This may be caused by the cutting head (34) Fig.A. becoming loose on its hinges which would permit a sideways motion on the cutting head. This can be determined by grasping the cutting head between thumb and forefinger and moving it from side to side to ascertain whether there is any looseness or play at the hinges in the rear of the cutting head. This should be checked with the control lever (4) Fig.A. in the down or vertical position, to permit the cutting head its maximum movement. If the hinge adjustment is correct, cutting head should move freely up and down but should have no wobble or play, sideways. To adjust cutting head loosen tension adjustment lock nuts (Fig.D.) as follows:

First insert screw driver in slot of tension adjustment screw, hold this steady without turning, then with a small end wrench loosen tension adjustment lock nut. Now turn tension adjustment screw to right 1/4 turn and then retighten lock nut keeping screwdriver in screw slot to prevent it being turned further than already set, until lock nut is tight. After adjustment is made, test movement of cutting head as described previously. Cutting head should move freely up and down with no play or wobble sideways. If cutting head moves up or down too stiffly, adjustment is too tight and this will result in a "wow". If adjustment is too loose, recording will still reproduce a "Flutter". Make adjustment of tension screw as described above to permit cutting head to move freely and easily up or down with no play or wobble from side to side.

Mechanical Data:-
The idler wheels are equipped with oilite bearings and require a very small amount of oil. Care should be taken in oiling to prevent the oil from coming in contact with the rubber. Idler wheels are mounted on a movable arm which automatically compensates for wear on the wheel and automatically increases and decreases the driving pressure as the load on the turntable increases or decreases. This feature minimizes "wows" due to changes in speed caused by varying loads on the turntable.

The overhead structure consists of a center post, a crossbar and a swivel. The lead screw is enclosed in a square protecting tubing. Revolving in the center post is a vertical shaft to which a worm gear is attached which in turn is engaged with a horizontal worm gear to which the feed screw is secured.

The lead screw which is enclosed in the square horizontal tube also has a bearing on its right-hand end consisting of a pointed steel screw and nut, which is visible at one end of the square tubing assembly.

The cutting head carriage slides over the square tubing and carries with it the cutting head assembly pivoted at the rear of the cutting head carriage.

The lever, located in front of the cutting head carriage, controls both the engagement of the carriage with the lead screw and the lowering of the cutting head over the record at the time of cutting.

The cutting head carriage should slide freely over the square tubing crossbar and the proper friction is automatically obtained by a spring and pressure pad assembly enclosed within the carriage itself and no adjustment need be made to change this friction.

The felt padding with which the recorder is equipped will take up ordinary wear and the spring pressure pad previously mentioned will compensate as wear occurs.

Should the carriage rock a trifle, this should not be construed as a defect because, in cutting, the spring pressure pads will compel the cutting head carriage to assume its proper position and slide smoothly across the square crossbar without any impediment, or rocking.

Crossbar Assembly:-
The overhead assembly should turn freely and this can be tested by holding the center post in the left hand, lifting the overhead assembly and turning the chromium plated knob pinned over the center post shaft, with the other hand.

Even when the control lever in the carriage is down, it should be easy to revolve the center post knob without any effort or binding.

The right-hand bearing of the lead screw (6) Fig.A. is probably the most delicate mechanical adjustment in the machine and the utmost care should be exercised before attempting to alter this adjustment.

As previously explained, this bearing consists of a conical hole drilled at the right-hand end of the lead screw into which the conical end of the steel screw is inserted. This construction is necessary to avoid any excessive friction caused by the thrust exerted by the lead screw in revolving and in view of its small surface will, from time to time, wear a trifle, thus causing a pattern in the grooves cut by the cutting head. This pattern takes the appearance of light and dark cuts into the records in groups of ten grooves but while this defect is not objectionable from an acoustical standpoint, it may, however, cause one groove to cut into the other in the event that the defect is too pronounced.

In order to correct it, it is necessary to secure a wrench to fit the nut which secures the bearing screw and to release this nut by turning to the left. Turn the bearing screw by hand without forcing it then secure it in place by tightening the nut again, making sure, however, that the adjusting screw does not turn. Test the adjustment by turning the center post knob and be certain that it revolves freely without any binding and make a test cut. When the adjustment is properly made, no pattern of the type previously described should appear.

Raising or Lowering Turntable:-
It has already been mentioned that the recorder is adjusted to cut 1/16" blanks. If a thicker record is used, a deeper cut will be obtained on the inside of the record and a lighter cut toward the outside edge. If a thinner record is used, a shallower cut will be obtained on the inside than the outside.

If, for any reason, it is desired to adjust the machine so as to cut either a thinner or thicker record, this adjustment can be made only by removing the recorder from the case and by turning the screw located at the bottom of the

center main bearing. Care should be taken in loosening the nut first and it is advisable to remember that for every complete turn the turntable is lifted or lowered by 1/32".

All Bogen recorders are designed for needles protruding 3/8" from the cutting head plate for cutting Acetate blanks. In this position, it is possible to cut as far in as the cutting head carriage will permit, although this practice is not recommended in view of the fact that the quality is impaired a great deal at such small diameter of grooves.

When the needle protrudes 3/8" the proper cutting angle is automatically obtained. If a greater angle is desired, the needle should protrude more. If a vertical position is desirable, then shorter needles should be used and should protrude less than the amount specified. (Refer to "Changing Cutting Angle")

Pressure on the cutting head, which is the factor determining the depth of cut, may be changed by the adjustment provided for in the cutting head carriage assembly at the right of the control lever (3) Fig.A. The pressure indicator (5) Fig.A. located directly underneath this adjustment and protruding in a slot at the right of the control lever indicates the position of the pressure adjustment spring and it is only an indication as to the position of the spring.

In view of the many types of record blanks and their consistency, it is impossible to accurately calibrate this adjustment in any way because the same adjustment gives a much deeper cut in a "fresh" or "soft" nitrate blank than it would on a harder one.

It should be remembered that no definite instructions can be given as to the depth of cut other than the fact that the shavings should be about the thickness of coarse hair. A light cut will offer less impediment to the motion of the cutting head and will result in better recordings; however, the cut should be deep enough to insure proper tracking when played back. Generally speaking, it is advisable to cut as lightly as it is possible for the pick up to follow and a little experimenting along these lines is essential for good recordings.

The phono playback pickup supplied with the recorder is of the symphonic type, having a microphone output and should be connected like a microphone to the mike input and <u>not</u> to the phono stage.

<u>Amplifier Connections and Data RA6:-</u>
Figure F shows the connections and cables for the portable recorders, Models 212RP and 16RP, when used in conjunction with the Model RA6 recording amplifier.

The cutting head cable and pick up cable furnished with the RA6 amplifier are joined to one plug which is to be inserted at the amplifier. The cable separates to two plugs which are inserted into the recorder. The recorder receives its power from the amplifier and the amplifier connects to the AC supply line by means of the AC cable provided.

The RA6 amplifier has a power consumption of 70 watts, on 117 volts AC, 60 cycles.

Tubes Used: -1-6J7G, 1-6K5G, 1-6L6G, 1-5X4G.

<u>Operation of RA6 Amplifier and Recorder:-</u>
<u>To Record From Microphone:-</u>
Refer to Figure F in this description.
Connect microphone to connector provided on upper left of panel. Connect all

cables as shown.

Turn amplifier on by rotating "Volume" control in a clockwise direction until a click is heard. Keep "Volume" control down, however, until ready to record.

Turn "Tone" control full on to the right in a clockwise direction. This is the brilliant position and is preferable in recording, as it is essential to record the entire frequency band.

Place "Record-Play" switch in "Record" position.

Turn "Volume" control to the proper recording level which is indicated by the swing of the needle on the meter. To determine proper level place microphone before the person making the recording and have him speak in a normal tone. Advance the "Volume" control until the needle swings to "0" on the scale for maximum peaks. The needle should not swing above "0" at any time.

After recording level has been determined, make sure cutting head carriage is set ready for recording as described in paragraph "To Record". Slowly lower Dual Action Control Lever on Recorder all the way down to its full stop. If lever is lowered rapidly, the blank record may be damaged and the carriage may skip one thread of the lead screw. Lower control lever slowly. (For Adjustments for depth of cut, etc., refer to "Adjustments".) When through recording, turn lever back counter clockwise to its horizontal position. Then slide carriage to extreme left of crossbar, turn motor switch off, lift crossbar and swing it over to rest post on the right. Before sliding carriage make sure control lever is in horizontal position to avoid damaging lead screw. After recording collect cut thread from record and roll into a ball, disposing of thread in a metal container, as it is inflammable. This precaution is not necessary with Phonoflex.

Monitoring during recording may be done with earphones by plugging into jack on upper right of panel.

To Play Back:-
Turn "Play-Record" Switch to "Play" position.

Insert playing needle in Playback pickup and place pickup on record at point where recording was started. Turn motor switch on and adjust "Volume" control up to desired level.

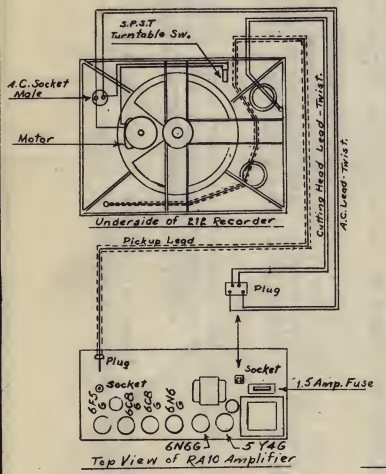
An external speaker may be used in place of the internal speaker by connecting a plug to the speaker leads and inserting it into the jack provided on the panel to the right of the tube opening. This will automatically cut out the internal speaker.

If a commercial record is to be played, remove the offset drive screw on the turntable.

The meter will not register on playback, but on recording only.

Radio Recording or Dubbing:-
To record from radio or to dub another record, an external input jack is provided on the panel to the left of the tube opening. Connect two wires from voice coil of radio loudspeaker to ordinary telephone plug and insert into this jack. Turn "Play-Record" switch to "Record" position. Tune radio to desired station and adjust for proper recording level as described under "To Record from Microphone". Proceed with recording as described in that section.

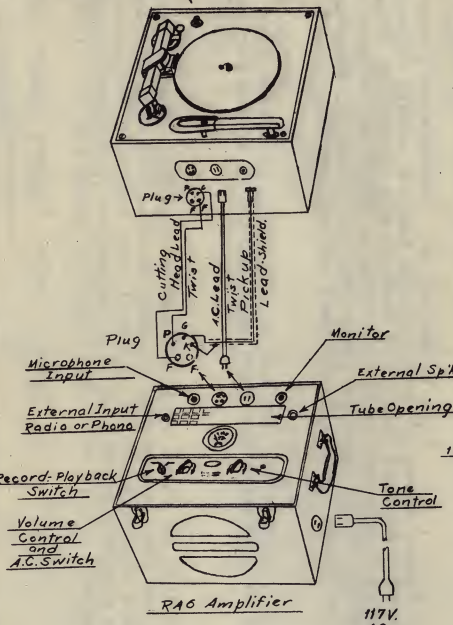
Figure E



Internal Wiring - Models E12RC and 16RC. Recording Systems

Turntable Sw.

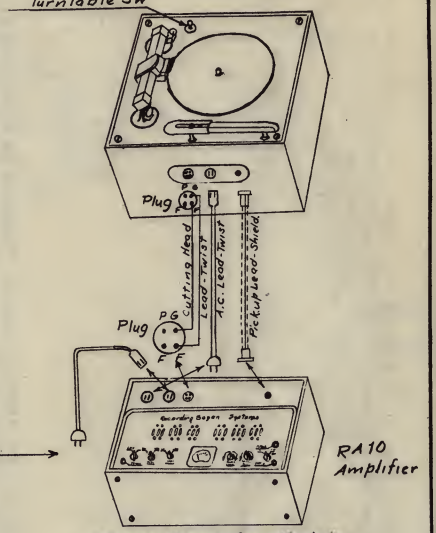
Figure F



Connections for Models E12RP or 16RP and RA6 Amplifier

Turntable Sw

Figure G



Connections for Models E12RP or 16RP and RA10 Amplifier

DAVID BOGEN CO., Inc.	
Subject: Interwiring Of Recorders	
Project:	
Project No.	
Drawn by: C.T.	Job No.
Checked by: Ben Waxler	Scale:
Approved by:	Date: 6-8-39

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A record may be dubbed by plugging an external phonograph (High Impedance) into the dubbing jack and proceeding with recording as for radio.

Amplifier Connections and Data RA10:-
Figure G shows the connections and cables for the portable recorders Models 212RP and 16RP when used in conjunction with the Model RA10 recording amplifier.

The cables are furnished with the amplifier and their connections are clearly marked in the illustration. Please note that the recorder AC cable plugs into the receptacle on the amplifier, and the amplifier connects to the AC supply line directly.

The RA10 Recording Amplifier has a power consumption of 75 watts, on 117 volts AC, 60 cycles.

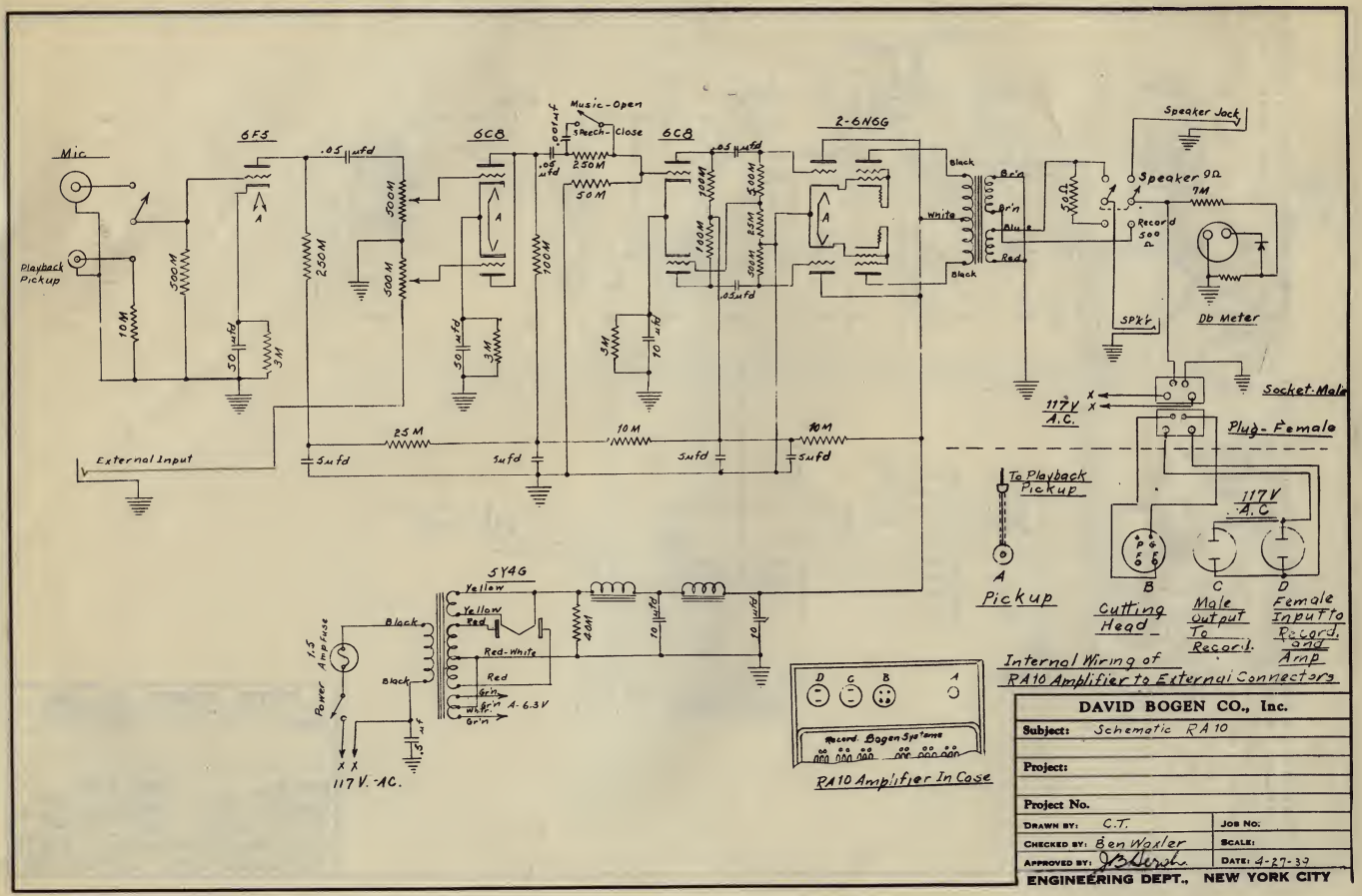
Tubes Used: 1-6F5G, 2-6C8G, 2-6N6G, 1-5Y4G.

The combination of the Model RA10 amplifier and either the Models 212RP or 16RP portable recorder is equivalent to the standard Models 212RC or 16RC complete recording systems. The operation of the complete combination unit is described in this instruction book on page 6 and this may be used in its entirety in the operation of the portable setup as illustrated in Figure G.

Service Note:-
The combination Models 212RC and 16RC have been designed so as to give quick and easy access to the tubes in the amplifier should it become necessary to do so.

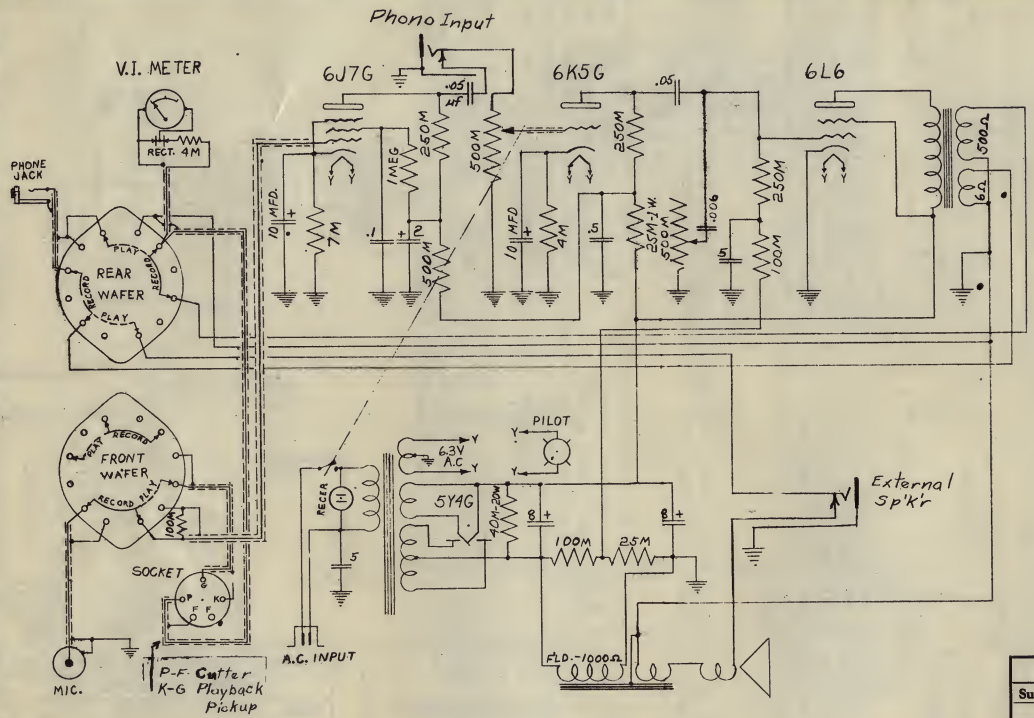
The amplifier is fastened to the front of the case, which is hinged on the bottom. Removing two screws in the upper corners of the large control panel, and two screws on the SIDES of the case, near the front, allows the amplifier to swing forward on its hinges. All tubes are now accessible for test or replacement. Figure E shows the position of these tubes, as well as the plug and socket arrangement for the amplifier.

Should it become necessary to service the amplifier, it may easily be removed by disconnecting the sockets shown in Figure E, then removing the four mounting screws on the swinging front of the case. This front may be entirely separated from the case proper, as the hinges are slip type.



Internal Wiring of RA10 Amplifier to External Connectors

DAVID BOGEN CO., Inc.	
Subject: Schematic RA 10	
Project:	
Project No.	
Drawn by: C.T.	Job No:
Checked by: Ben Wexler	Scale:
Approved by: J.G. Bogen	Date: 4-27-39
ENGINEERING DEPT., NEW YORK CITY	



DAVID BOGEN CO., INC.	
Subject: MODEL RA 6-1 SCHEMATIC	
Sheet No:	Scale: NONE
Drawn by: A.D.	Date: 8-12-38
CKD Ben Waxler APPD	
THIS PRINT SUPERSEDES ALL PRINTS MADE PRIOR TO	6-14-39
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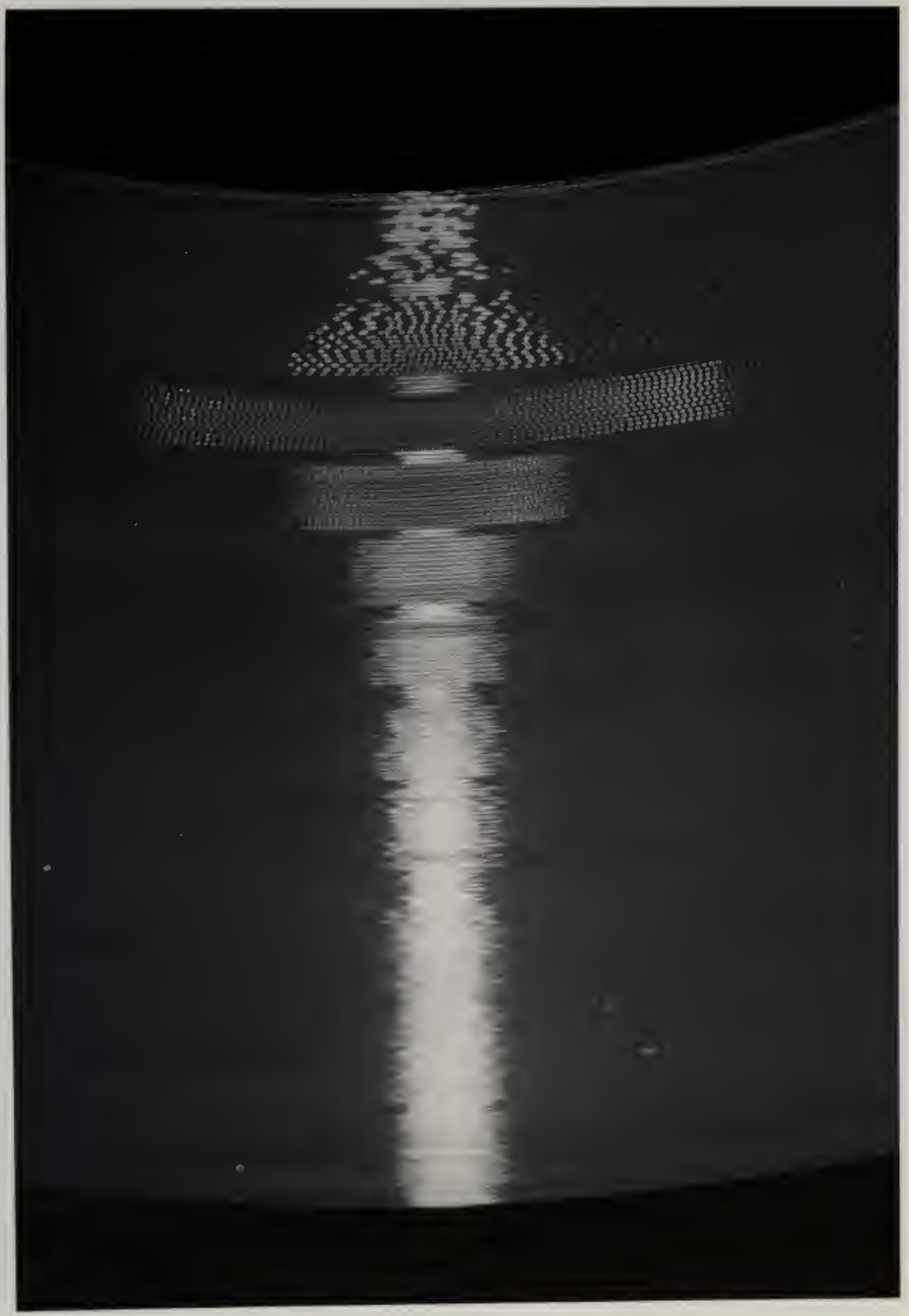
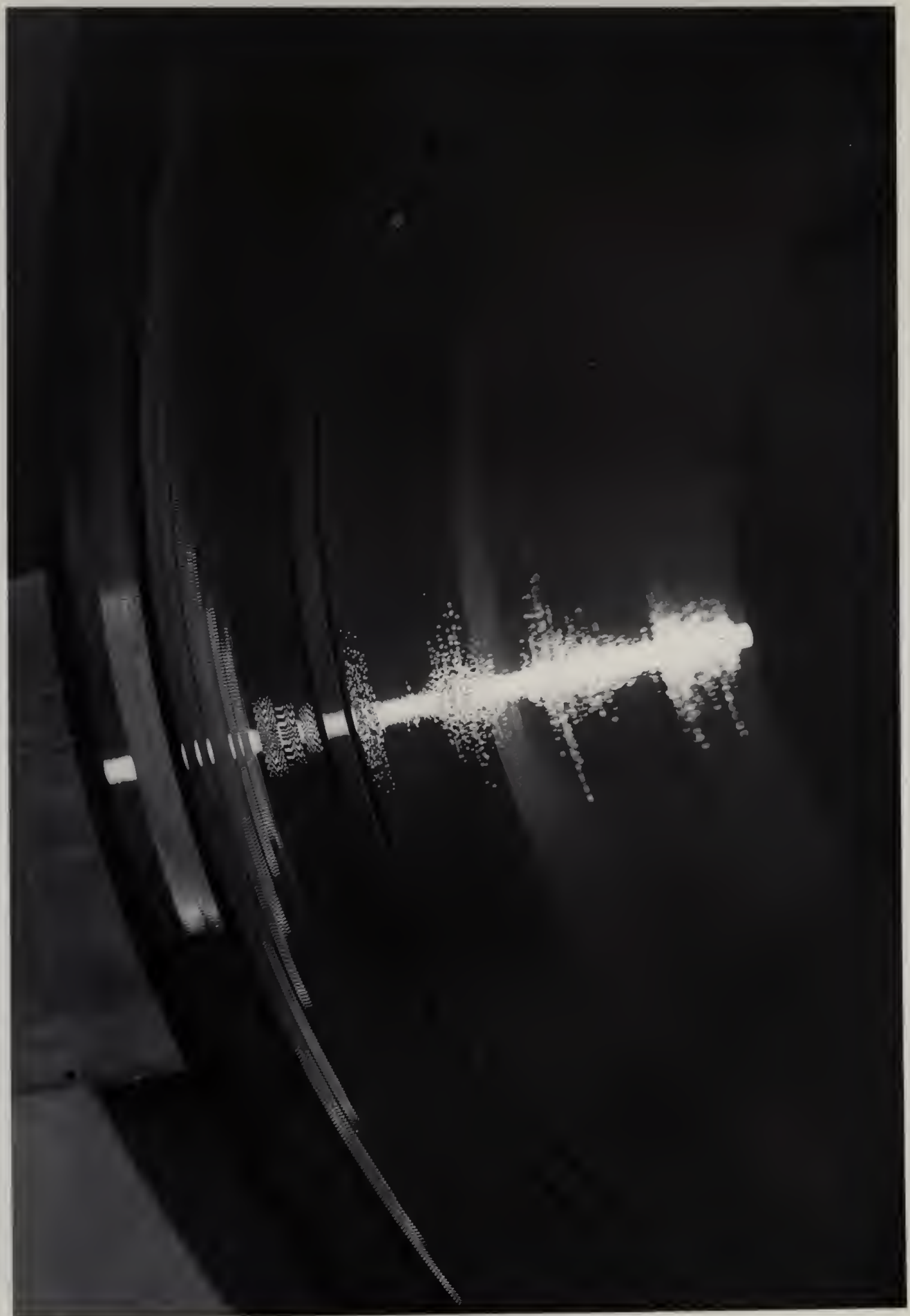


Bergen 212 RC.

4

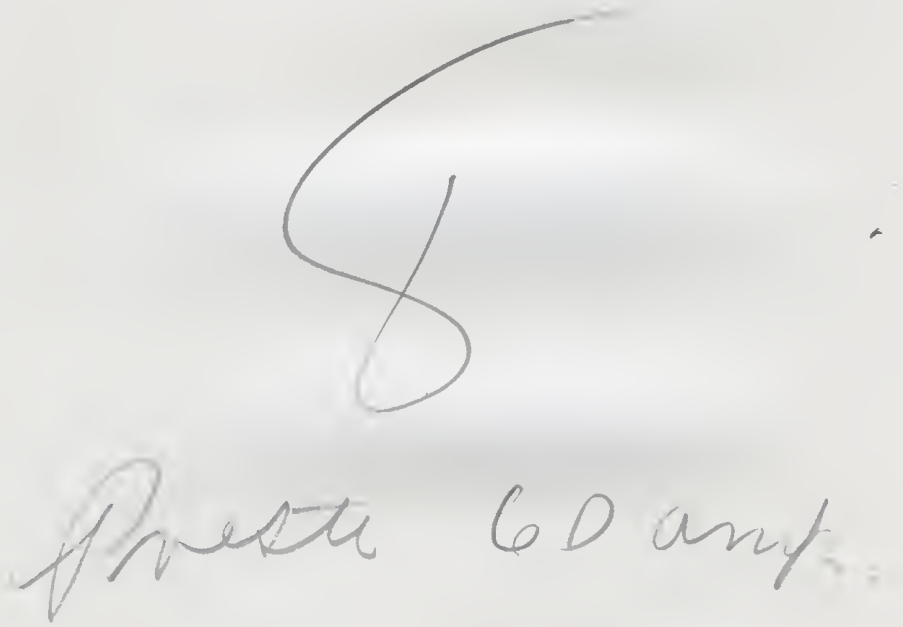
Bergen 212 RD

7



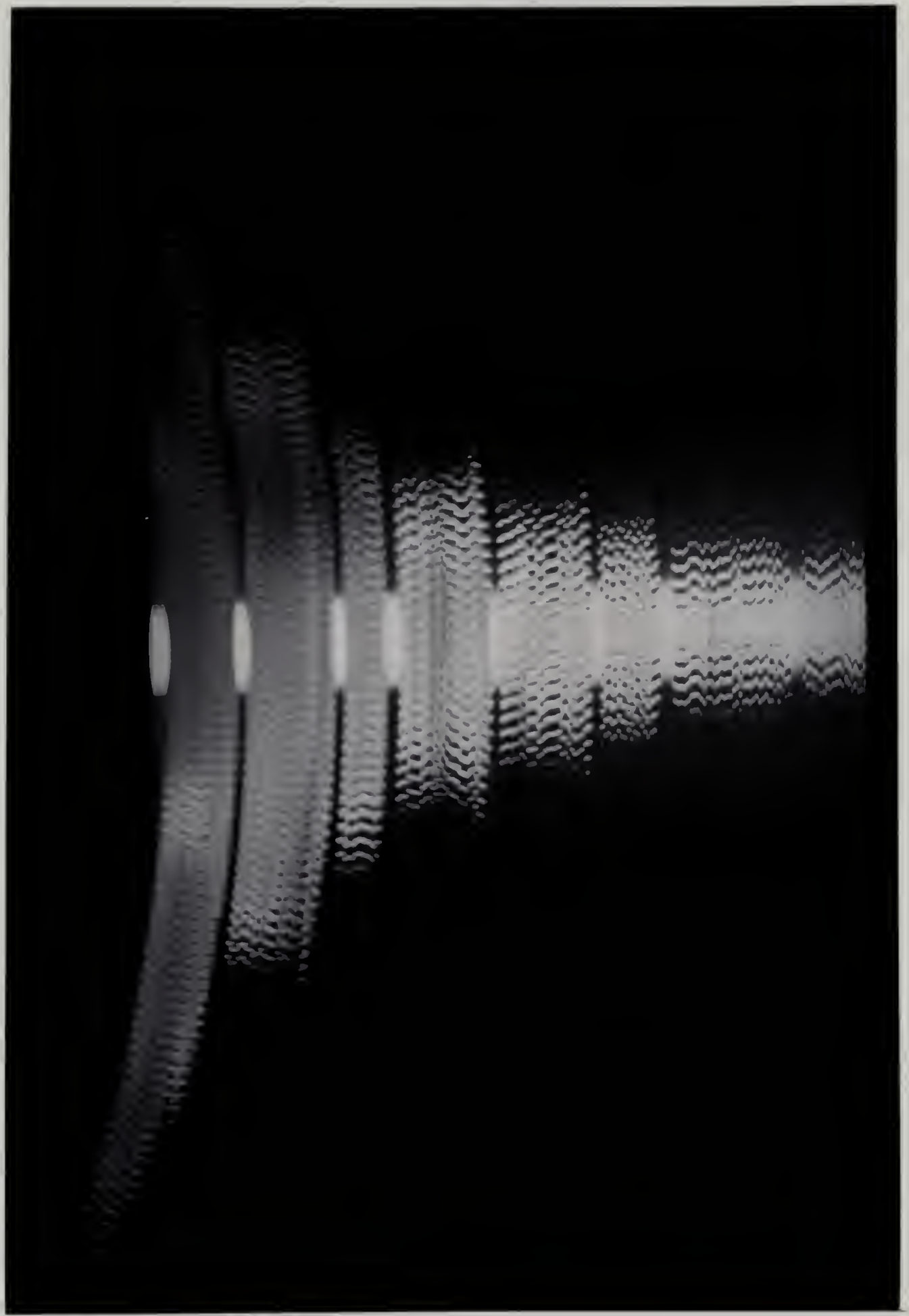
RCA

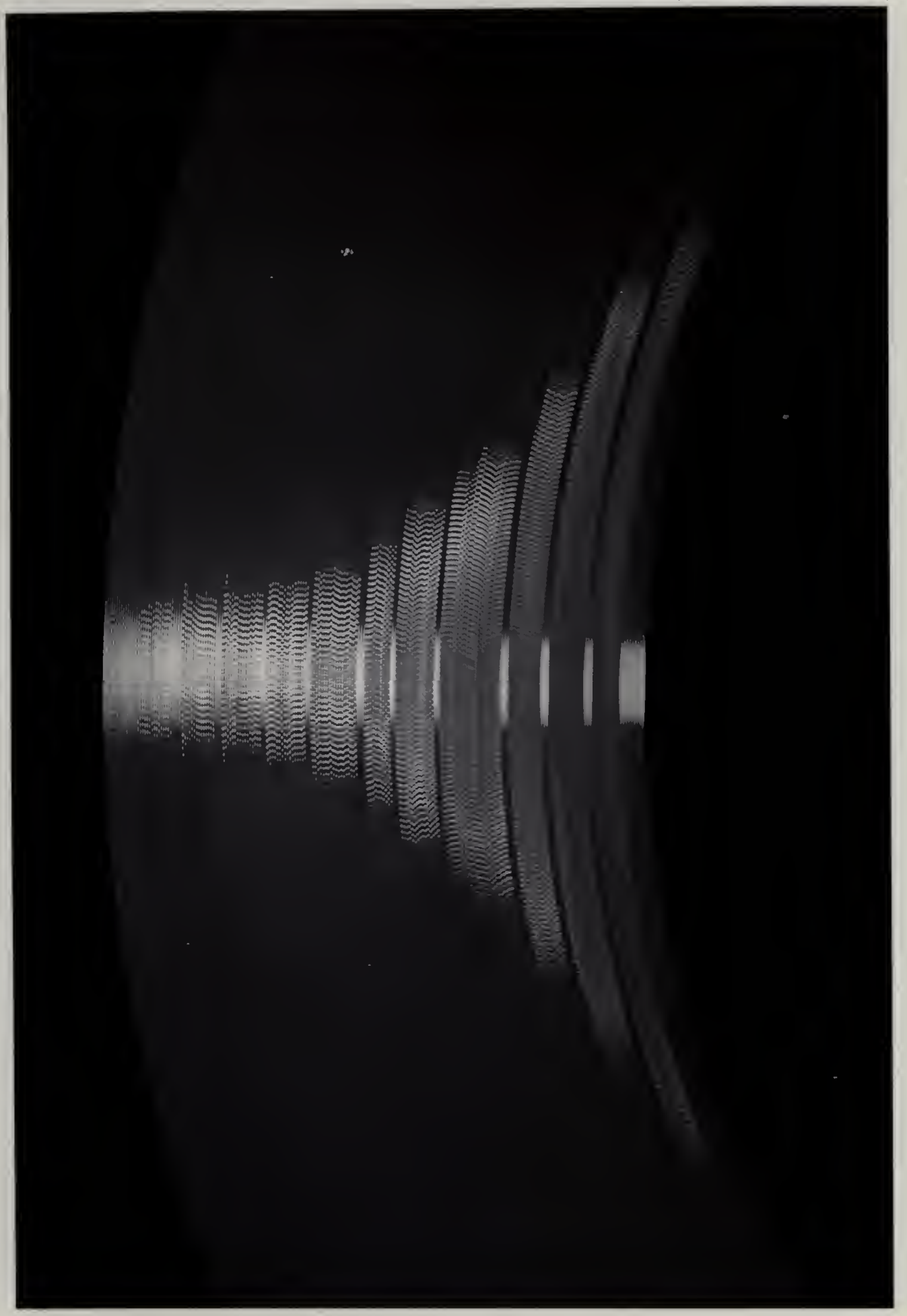
amp.



Universal Army

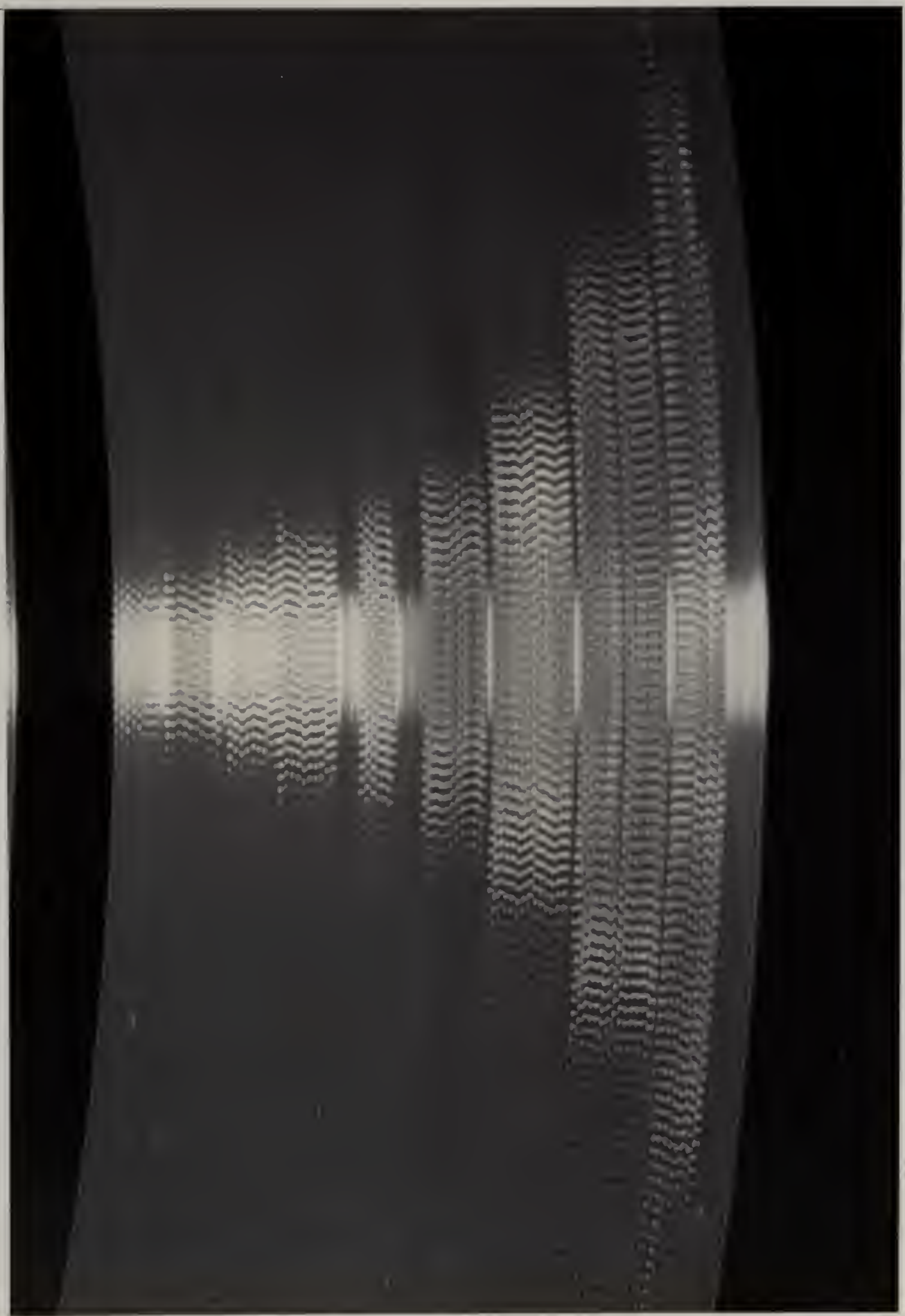
3





Unusual amp

2



Boyer

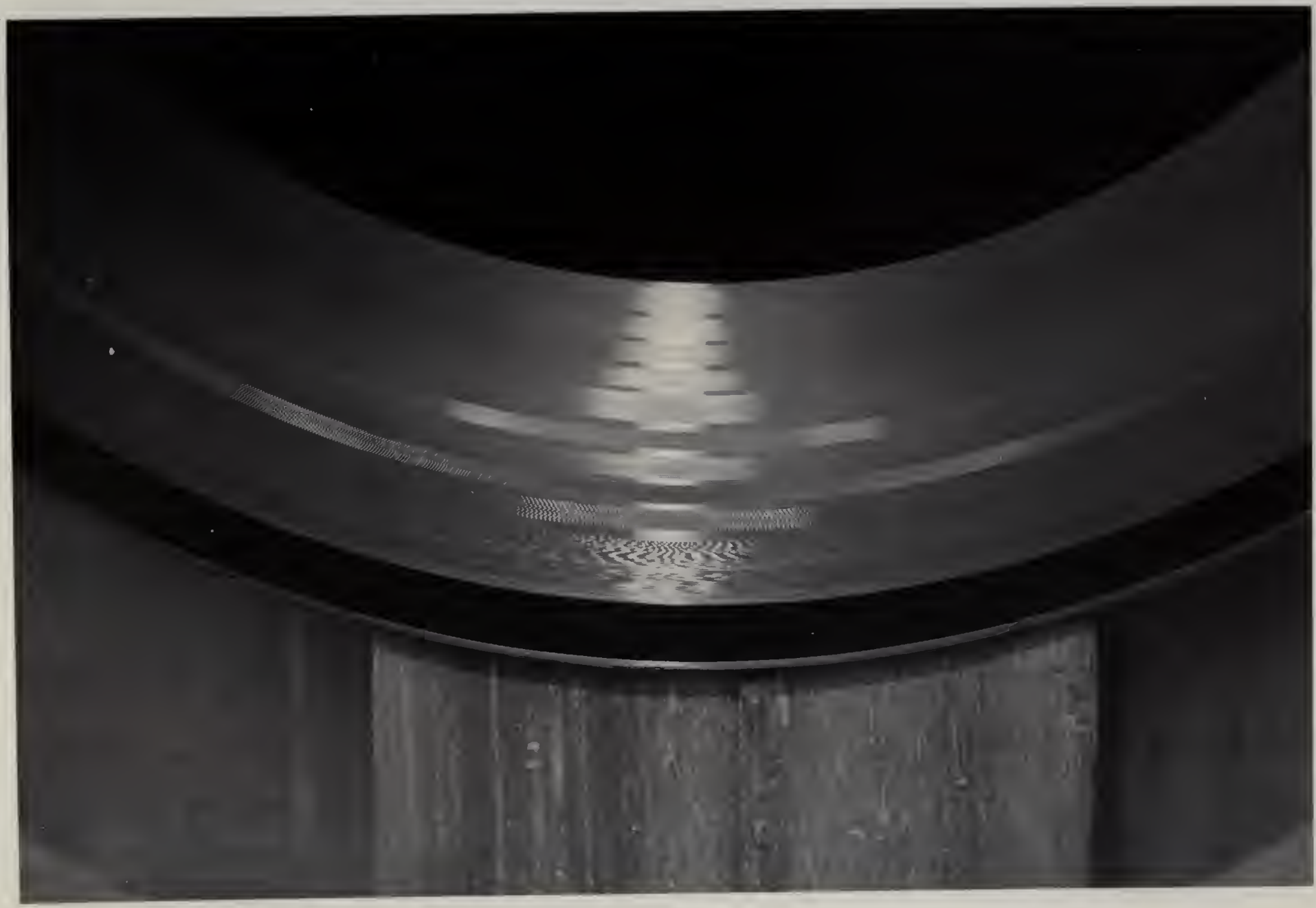
16 R.P.

9

Presto y amp.

PRESTO

Radio tone



Universal

Uni-Cord

Scanned from the National Association of Educational Broadcasters Records
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